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POWER FOR AN OHIO RAILWAY

TURBINE STATION WITH BAROMETRIC CONDENSERS AND HYDRAULIC ASH HANDLING

BY W. J. MAXWELL

THIS station is located at Lindenwald, a suburb of Hamilton, Ohio, and has been in operation the past 18 months, although the full boiler installation is yet to be completed. It was built to furnish power for the Cincinnati-Dayton Division of the Ohio Electric Railway Co. Previous to the building of this central station which as yet is not worked to its full rated capacity, all power on this division of the road was supplied by 4 independent direct-current power stations, the current being generated at 650 volts.

These stations were located about 15 miles apart and could be operated independently of each other or in parallel. Most of the time they were running in parallel and since the new station was started, some

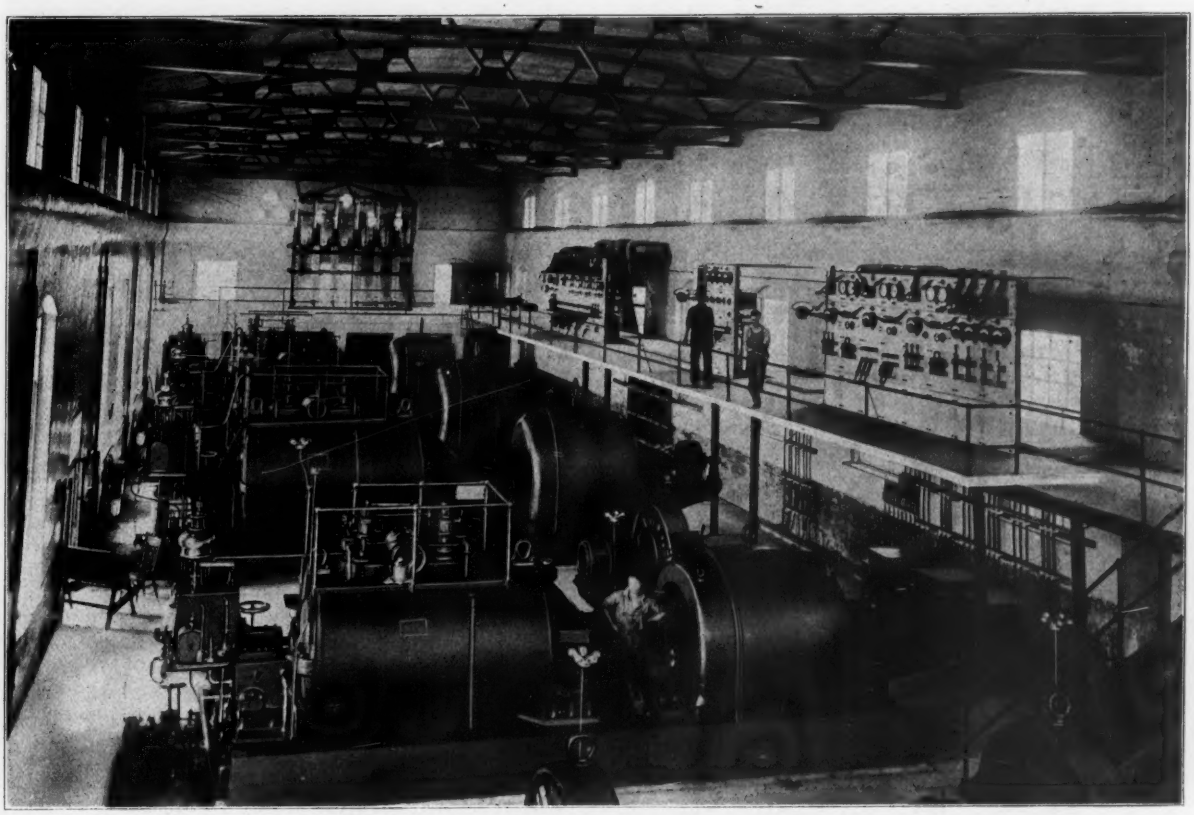


FIG. 7. VIEW OF ENGINE ROOM SHOWING TURBO-GENERATORS AND SWITCHBOARD

of them have been changed by adding a rotary substation in connection with them. Others have been entirely dismantled and the machinery disposed of.

Figures 1 and 2 are general outside views of the building from the 2 sides, showing it to be a 2-story structure with 2 basements, extending the full length. It is 180 ft. long, 50 ft. wide and about 70 ft. high measuring from the basement floor; each floor contains about 9,000 sq. ft. of floor space. Both boiler and engine rooms have high ceilings, abundance of light and are well ventilated, and the machinery has been so placed as to give ample room for all kinds of work in any part of the rooms and on any part of the machines or boilers without crowding.

Materials for the buildings are steel, brick and concrete, the substructure being concrete with a super-

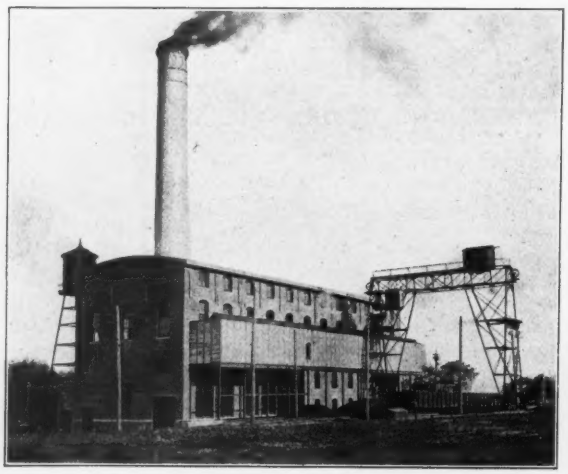


FIG. 1. EXTERIOR OF BUILDING FROM LAND SIDE SHOWING COAL CONVEYOR AND BUNKER

structure of brick. The walls are 21 in. thick. The boiler room floor is concrete 9 in. thick, and the engine room floor 18 in. of reinforced concrete, and supported by 24-in. I beams. The roof is cinder concrete 6-in. thick, reinforced, and covered with felt, tarred and graveled. Steel trusses are used to support the roof and these rest on the side walls. The building was constructed with the idea of making it strong, durable and as near fireproof as possible, the finish being of the plainest, as service and not appearance was the main idea in the construction.

Coal is handled by a Gantry crane made by the Fairbanks, Morse Co. of Chicago, which crane travels the entire length of the building over a storage pit for coal. This pit is of concrete, 180 by 60 by 12 ft. and has a storage capacity of about 3,000 tons. Cars to be unloaded are run in over the pit and the crane unloads directly from the cars to the bunkers or from the cars to the storage pit as may be desired. When no cars are on the siding, the crane lifts the coal from the pit to the bunkers. All coal in going to the bunkers passing through a McCaslin electrically driven coal crusher, which runs in connection with the crane.

Coal Handling

To unload a 50-ton car of coal requires from 40 to 50 min, the grab bucket, which is the clamshell type, taking about 2,400 lb. to a load. Any coal left in pockets or corners of the car which cannot be reached by the crane is dumped into the storage pit.

Coal bunkers are of reinforced concrete with a storage capacity of about 500 tons, and are on a level with the engine room floor, extending the full length of the building. These bunkers are supported by a steel substructure, the roof being sloping, made of concrete, and supported by steel trusses.

A view of the crane and coal bunkers is seen in Fig. 1.

Ash Handling

All ash and clinkers are dropped into ash pits located in the basement from which the ash is pulled into a concrete trough about 16 in. wide and 10 in. deep. This trough is built in front of the ash pit, has a 3-ft. fall across the building, and connects to a 16-in. pipe leading to the river. When pulling ash, a 6-in. water line, leading from the circulating pump to the ash trough is, opened and under a pressure of about 10 lb. from the pump, with the fall in the trough, the current is sufficient to carry all ash and clinkers to the river.

Ash is not washed into the river except when there is a good stage of water and at all other times the ash is taken out in steel dump cars of about 2 yd. capacity and loaded into Rogers steel dump cars to be

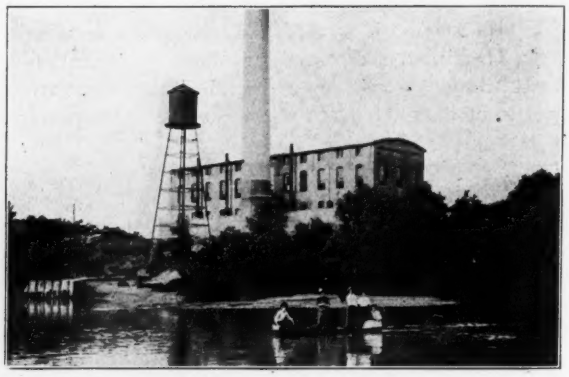


FIG. 2. VIEW OF STATION FROM RIVER SIDE SHOWING WATER INTAKE AND TANK

hauled along the road bed for filling and ballast. Fig. 3 shows the ash handling arrangements in the basement.

Water Supply

To the west of the building about 200 ft. flows the great Miami River, from which the water supply for the plant is taken. Water is brought into the building through a concrete intake tunnel which can be seen in Fig. 2. This is arranged with the discharge from the building to the river vertically above the intake and arranged to deliver the water some feet down the river from the intake. Where they enter the building, the hot well and intake are side by side, the hot well tube being dead ended at the building so that there is always sufficient water in the hot well to seal the tail pipes of the condensers. The intake side is next to the boilers.

Two pumps for supplying water to the tank and for feed water are located in the basement directly over the hot well, from which they get their water supply. They are 10 by 12 by 18 in., made by Boyts and Porter and elevate the water to a 500-barrel tank 70 ft. in height, which tank furnishes water for cooling the oil, sealing the glands on the turbine, for lavatory and other purposes about the plant. All cooling water from the turbines flows by gravity to the heaters, any additional amount needed flowing direct from

tank to heaters, being controlled by a Mason regulating valve, operated by a float in the heater.

In the same basement is located a fire pump from which water connections are piped to all parts of the plant. This pump is also used for washing boilers, running the turbine cleaner during boiler cleaning and in case of mishap, the boiler feed pump can be used for that purpose.

Boiler Feed

This consists of 2 Boyts & Porter outside packed plunger pumps, 20 by 12 by 30 in., either pump having ample capacity to supply all boilers. They are set about 8 ft. below 2 open heaters, built by the Platt Iron Works which raise the temperature of the feed water to about 200 deg., using the exhaust steam from

FIG. 3. VIEW OF ASH-HANDLING ARRANGEMENT IN BASEMENT

the boiler feed, circulating and tank pumps. Heaters and feed-water pumps are located in a room adjoining the boiler room and to protect the water lines leading from pumps to boiler in case of over pressure, 2 2-in relief valves have been placed on this line.

Condensers and Circulating Pumps

To the rear of the boilers is an offset basement, 10 ft. below the boiler room floor, in which are located the 4 Boyts & Porter circulating pumps each 20 by 36 by 48 in. and containing 48 9-in. rubber valves; 24 on the suction and the same number on the discharge. The plungers on the water ends are of hard wood, built up in sections. The intake and hot well are located beneath the circulating pumps, the supply for these pumps being taken from the intake side of the tunnel and lifted about 12 ft. Three of these pumps supply 4 twin barometric condensers made by Wm. Baragwanath & Sons, Chicago, and the 4th supplies water to a single condenser of the same make.

For priming these pumps, a 2-in. water line with tank pressure connects to both suction ends. On the discharge side of the pumps is a pressure gage and a temperature gage and on the tail pipe from each condenser to the hot well is also a temperature gage. No dry vacuum pumps are used, but a vacuum of 26 to 28 in. is maintained, depending upon atmospheric conditions.

Condensers are located along the side walls to the rear of the boilers as shown in Figs. 4 and 5 and as close to the engine room floor as possible. The amount of water supplied to the condensers can be regulated from the engine room by operating 2 hand wheels on a screw stem passing through a yoke. These condens-

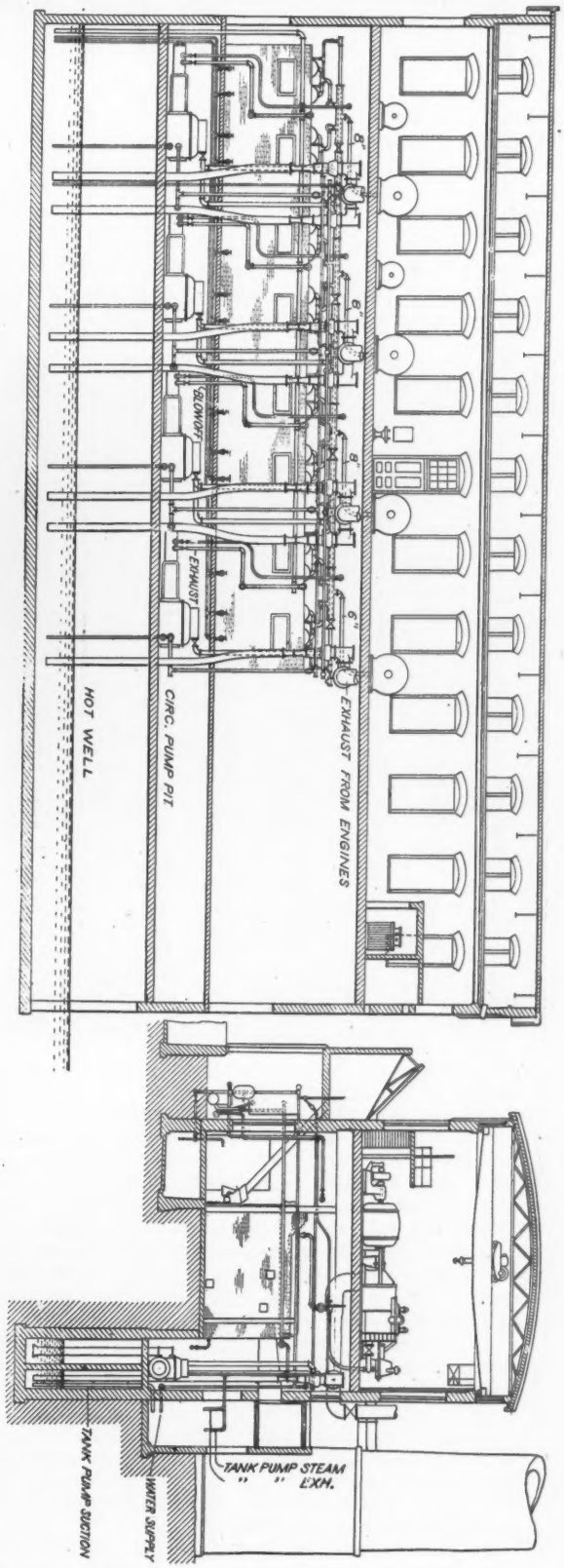


FIG. 4. SECTIONAL ELEVATIONS OF STATION SHOWING ARRANGEMENT OF MACHINERY AND PIPING

ers are flanged into a 36-in. pipe, taking the exhaust steam from the turbines to the atmosphere. Condensers and exhaust pipe are hung from 2 24-in. steel I beams by means of beam clamps and 10-in. channel iron passing beneath the exhaust pipe and condensers. At the point where the exhaust pipe leaves the building, the pipe rests on a cast-iron saddle which supports one end of the exhaust pipe, the atmospheric valve and a 24-in. spiral riveted galvanized iron pipe which leads from the atmospheric valve up above the roof of the building.

Boilers

On the ground floor is the boiler room in which are at present 8 boilers in operation. Foundations are laid

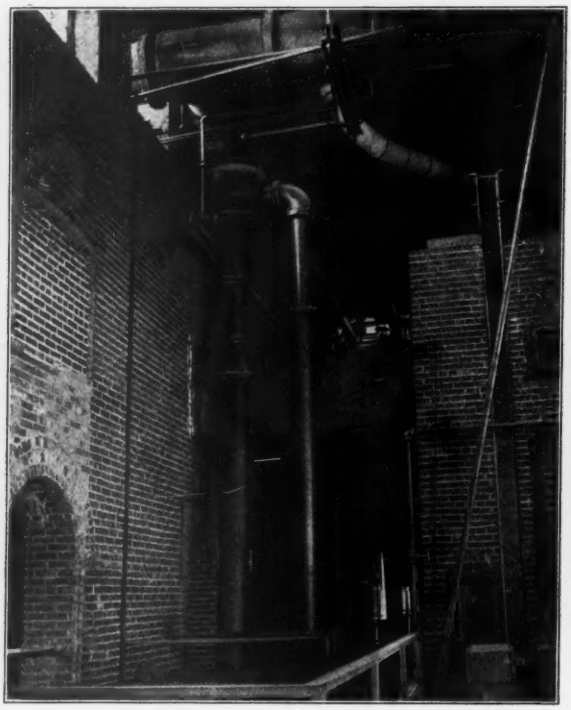


FIG. 5. BAROMETRIC CONDENSER AT REAR OF BOILER

for 4 additional boilers which will soon be erected, all being Babcock & Wilcox boilers of 400 rated horsepower each. Two 42-in. steam drums are used on each boiler, suspended by straps passing around them. The boilers are carried by channel irons resting on steel columns and are set in batteries of 2 each. They are all of steel construction, designed for a working pressure of 200 lb. although running at present under 160 lb. Each boiler has 192 4-in. tubes, 18 ft. in length, arranged in 16 sections of 12 tubes each.

Each boiler is supplied with the Babcock & Wilcox superheater of forged steel, designed to give a superheat of 100 deg., and the boiler delivers from 80 to 90 deg. superheat at the turbine throttle.

Blowoff from these boilers and superheaters is led down into the intake tunnel, each boiler having 2 separate 25-in. blowoff lines and each superheater one such line. On each blow-off line is an angle valve and an asbestos packed plug cock.

On each boiler is provided a high and low-water alarm and 4 safety valves, 2 4-in safety valves being directly on the boilers and 2 3-in. valves on the superheaters. The superheater safety valves are set to blow at a lower pressure than those on the boiler and are piped into a common header which exhausts outside the building.

Detroit automatic stokers designed to burn a low grade fuel successfully and economically are fitted to the boiler furnaces, Fig. 6. These stokers have screw feed, coal being let down from the bunkers to the stoker magazine through 15-in. delivery spouts, 2 to each furnace. One stoker engine operates 2 furnaces. steam for running these engines being taken from the bottom of the main steam header. As one or more of these engines is in continuous operation, the steam piping from header to stoker engines has been so erected that as long as any of the engines are running, all parts of the main steam line are kept drained and free of all condensed water. Exhaust from these engines goes into the ash pits, assisting in loosening the clinker.

From each boiler a steel breeching connects to the smoke flue which is in common and is built on the outside of the building, extending the full length. This flue is 8 by 8 ft. except where it enters the stack it is 8 by 15 ft. The sides of this flue are of brick and the top and bottom of concrete. Located at the center

FIG. 6. VIEW OF BOILER FRONTS SHOWING STOKERS AND DELIVERY SPOUTS

of the flue is the radial brick stack, 180 ft. in height and with a uniform inside diameter of 12 ft., giving a draft of 1.1 in. of water. A ladder is built on the inside of the stack.

Control of the draft is obtained by a main damper in the stack together with a close fitting damper in the steel breeching of each boiler. A band of copper having 4 platinum tips encircles the top of the stack and is grounded to an all copper plate buried in the river bed about 50 yd. distant.

Steam Piping

Throughout the plant, the piping was built for high pressure and 100 deg. superheat. Atwood joints with steel corrugated gaskets were used in all steam piping which is extra heavy steel with fittings and valves to correspond. The entire piping system with valves and fittings was furnished by the Pittsburg Valve, Foundry and Construction Co.

Connection from each boiler with the header is made by 2 5-in. Shelby Seamless steel pipes made with long bends and entering the 10-in. main steam header

on the under side of the line. Three 8-in. branch lines and 1 6-in., take steam from the top of the header making long sweep bends, passing up through the engine room floor and connecting to the turbines.

In a general design of the steam piping, short and direct connections to the turbines with allowance for expansion and drainage have been well accomplished. The main steam header is hung from floor beams by means of clamps and hangers with a bracing to prevent vibration. No steam traps or steam separators are used. Figs. 4 and 8 give a good idea of the general design of the piping. All piping and valves for steam lines and boiler breechings are covered with extra heavy asbestos covering.

In alcoves at the north end of the building are the step-up transformers arranged in banks of 3 each. One bank feeds north from the station and the other bank south. Each group of transformers is connected in delta on both high and low voltage sides, the low-tension delta being arranged on the back of the alternating current switchboard so that the cables are led directly from the board to the terminals on the low-tension side of the transformers.

The high-tension deltas are placed in an enclosure directly behind the transformers and feed into 2 groups of 3 bus bars. Normally these 2 sets of bus bars operate independently, one set feeding to the north

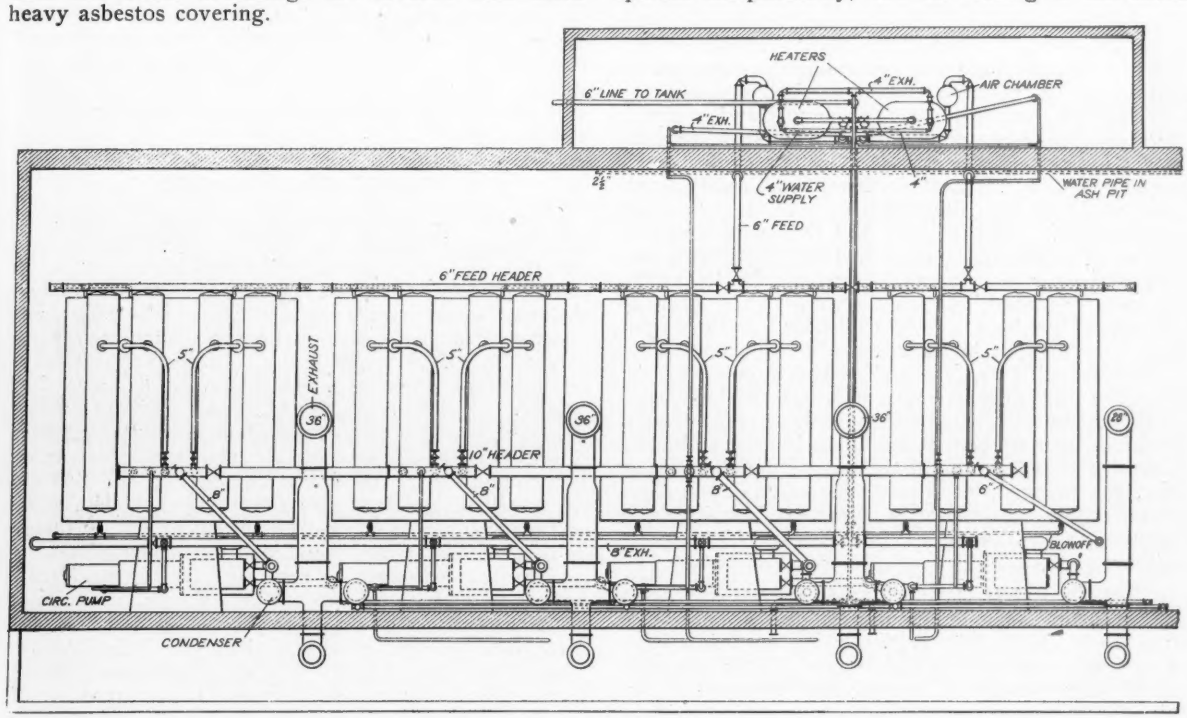


FIG. 8. PLAN VIEW OF STEAM AND WATER PIPING

Engine Room

On the 2nd floor is the engine room containing 4 Westinghouse-Parsons turbo-alternators of the enclosed type and also 3 300-kw. rotary converters, 6 oil-cooled step up transformers of 500 kw. each and 3 oil-cooled reactance coils. The turbines are of the standard single flow type, the main bearings being split and babbitted and a flexible coupling connecting the alternator to the turbine shaft. These turbine units run at 1500 r. p. m., delivering 3-phase currents at 370 volts and 25 cycles. Each unit has its own exciter, which is a shunt-wound dynamo, direct driven from the alternator shaft. These exciters all run in parallel, supplying current to a common exciter bus.

The alternators are of the enclosed type with forced ventilation, air being taken from the outside of the building by a duct and the hot air discharged down over the boiler settings. Each of these turbo units has a foundation of 2 24-in. I beams, 100 lb. to the foot, each beam being supported by side walls and 2 14-in. steel box columns which have been filled with concrete to give them as great stiffness as possible. Figure 7 gives a view of the engine room. Each turbine has connected to the exhaust side a vacuum gage and a mercury column for indicating the back pressure.

and the other to the south, but in case of emergency, provision has been made for connecting the 2 sets of buses together so that either or both banks of transformers may feed both north and south. Switches are provided for disconnecting each delta from the buses.

Westinghouse oil insulated choke coils are placed between the lines and the buses, and further protection from lightning and high-pressure strains is afforded the transformers by Westinghouse Multigap low equivalent lightning arresters, the ground for which consists of a large copper plate buried in the river. The cables are all laid in fiber conduits about 7000 linear ft. of cable being used in the plant.

Switchboard

This extends along the side of the building and across the end, and is constructed of Vermont gray marble. It sets about 6 ft. from the wall, giving ample room for any kind of work behind the board while current is on the line.

The alternating current section has 4 generator panels and 2 feeder panels, supplying current to the low-tension side of the transformers. A Westinghouse polyphase integrating wattmeter is mounted on the lower section of the feeder panels and an alternating-

current ammeter on the middle section; circuit breakers occupy the upper section. On the feeder panels are mounted 2 alternating-current voltmeters, a synchroscope, and lamps for parelleling machines and rotary converters.

Besides these circuit breakers and switches, there are mounted on the generator panels an alternating-current ammeter, indicating wattmeter, and a direct-current ammeter for the field current. The field resistances are mounted on the angle irons which support the switchboard from the wall, the rheostat dial being suspended just below them.

Three panels make up the exciter board, 2 of these carrying the switches, ammeter and resistances and the third having 2 Terrill voltage regulators, either of which can be used to regulate the voltage on all generators. The direct-current switchboard has 8 panels, 2 of them being feeder panels and carrying switches, breakers, ammeters and recording wattmeters for 4 feeders. Each of 3 rotary converters is supplied with an alternating-current and a direct-current panel; on the alternating-current panel is an ammeter, power-factor meter and line fuses, switches for the induction motor and a synchronizing rheostat.

Reactance coils giving a drop of 21 volts at 500 amperes are placed between the rotaries and alternating-current bus bars. They are located on the engine room floor, directly beneath the rotary board.

On the gallery at the end of the building are located the lightning arresters and high-tension circuit breakers. No oil switches are used, the high-tension breakers opening the 33,000-volt circuit in the air. Beneath the gallery and at the rear of the transformer cells is a fireproof compartment, containing 6 high-tension choke coils, series reactance for lightning arresters, the delta and disconnecting and high-tension switches.

Air System

A Westinghouse compound air pump and storage tank are located in the engine room, air being piped to various parts of the building for many purposes. In the engine room it is used for blowing out machines, cooling coils or turbines, etc., and in the boiler room it is used at times for running the air turbine in boiler cleaning.

Oiling System

In the basement below the smoke flue is the oiling system, consisting of a Turner oil filter, 1 400-gal. settling tank and 2 200-gal. storage tanks. Two oil headers run along the side wall beneath the engine room floor. The oil is lifted by a pump from the storage tanks to the turbines and flows from the turbines by gravity to the filter.

Crane

In the engine room is a Niles Electric Crane, of 20 tons capacity, used for lifting all heavy parts of the machinery about the engine room or raising and lowering articles between floors.

Transmission

Current for transmission to the substations is stepped up from 370 volts to 33,000 volts and is supplied at this voltage to 5 substations. For the substation located in Cincinnati, it is stepped down to a low potential at the city limits for transmission inside the city.

Operation

This plant operates under conditions quite unfavorable to the best economy. For about 12 hr. each day, 6 hr. in the morning and 6 in the evening, the load is double that during the middle of the day, thus requiring 2 extra boilers to be under steam; even under these unfavorable conditions, a kilowatt is produced for about 3.75 to 4 lb. of coal per hour. During the peak load, which lasts about 12 hr. each day, 2 1500-kw. machines are running. For about 6 hr. of the day, 1 1500-kw. answers the purpose. From 1 a. m. to 5 a. m. the small machine of 750 kw. capacity carries the load and lights.

Daily reports are kept showing the coal consumed, labor, repairs and all incidental expenses. Monthly reports show the total cost per kilowatt delivered for the month.

At the time of erection, this station was a radical departure in turbine installation but has proved very successful and practical. It was designed by Thomas Elliott, consulting engineer for the Ohio Electric Railway Co. and the plant was installed under his supervision.

TRANSMISSION ROPE

The economical transmission of power is an important question to every large manufacturing concern, and one that should have the most careful attention when planning new plants, to the end that the system installed shall be the most efficient as well as the most economical under the conditions presented by the individual case to be considered. The development of the rope drive in recent years has been such that no owner of a manufacturing enterprise of any size can afford failing to investigate the merits of this system when installing the power plant. Once having decided that rope drives are adapted to a certain service, the points that demand attention are the proper designing of the system; the careful selection of the materials, in which the question of quality should be the deciding factor; proper and careful installation.

The best transmission rope is made from Manila hemp selected with the greatest care for this special and exacting service. Proper lubrication is secured in a way that gives practical results without any injury to the fiber of the rope. Foreign substances should be avoided, such as are sometimes used, ostensibly for some useful purposes, but their real function seems to be only to give additional weight, which to the buyer means additional cost, without serving any practical end.

AN INVESTIGATION AS TO THE PRACTICABILITY of reforesting the great areas which have been devastated by fire and which are now lying barren and unproductive is now being carried on by the United States Forest Service in the Olympic National Forest in Washington. The area was at one time covered with a magnificent forest of Douglas fir, but was first burned over in 1890 and again in 1895. A third fire over almost the same area occurred in 1906, destroying the last remnant of the original forest, leaving the entire area treeless.

In some regions a second growth of trees will come in naturally after a burn, but often, some means, such as planting trees or sowing seed, is necessary to restore the forest. The burn in the Olympic Forest is of this nature and a series of experiments is planned to determine the proper methods of reforesting the area. Douglas fir will be the species used.

This fall a large quantity of Douglas fir seed will be collected and a quantity sown, some by scattering, some by raking in, some by planting in hills. Next spring the experiments will be repeated, and it is expected that the results obtained will indicate what methods and what seasons of the year are best adapted to the conditions found on this burn.

THE AIR-STEAM ENGINE AND ITS PHILOSOPHY

By E. J. Christie

WHY does the air-steam engine, shown in Fig. 1, possess great steam and fuel economy?

The cycle of operation is as follows: On the first stroke, the cylinder fills with atmospheric air, taken in through the hollow piston extension tube, hollow piston and piston valves. On the second stroke, occurs the compression of this air in the cylinder clearance; on the third stroke steam is admitted into this compressed air down to point of cutoff, then the mixture expands to end of stroke; the fourth stroke is exhaust.

Recent experiments and extensive tests have fully demonstrated the great economy of this system, but the thinking mind will naturally ask the reason why.

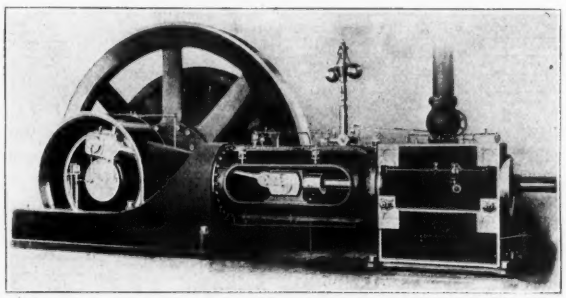


FIG. 1. CORLISS ENGINE FOR USING AIR-STEAM MIXTURE

The Philosophy of the Air-Steam Mixture

When the wet air in the cylinder has been compressed to approximately the same pressure and temperature as that of the saturated steam in the boiler, and the steam introduced into this compressed air down to the point of cutoff, the resulting mixture is highly superheated, as is clearly shown by the following illustration.

When a cubic foot of saturated steam, A, at 150 lb. absolute pressure and 358.3 deg. F. temperature, is mixed with a cubic foot of compressed air, B, at the same absolute pressure and temperature, by breaking away the partition between the 2, it is self evident that the temperature of the resulting mixture will remain the same, 383.3 deg. But this is a high degree of superheat; for the pressure of the mixture is 150 lb. absolute per square inch, but this 150 lb. is made up of 75 lb. steam pressure and 75 lb. air pressure, as shown by the second of Dalton's Laws, which follow:

Dalton's Laws

First. The pressure, and, consequently, the quantity, of vapor which saturates a given space, are the same for the same temperature, whether this space contains a gas or is a vacuum.

Second. The pressure of a mixture of a gas and a vapor is equal to the sum of the pressures which each would possess if it occupied the same space alone.

If the steam of this 150-lb mixture was just saturated (75 lb. due to air and 75 lb. to steam, under Dalton's second law), the temperature of this saturated mixture would be the same as that of 75 lb. steam or 307.4 deg. F. But the temperature of the initial mixture is 358.3 deg. F. The difference between 358.3 and 307.4 deg. saturation is 50.9 deg. of superheat. The great economy of superheat is too well known to need further comment here.

A larger proportion of air and a correspondingly smaller proportion of steam in the mixture will produce a greater degree of superheat. Hence the importance of securing the proper ratio for the greatest economy.

Utilization of the Latent Heat of Steam

By far the greatest economy of the air-steam mixture is founded on the following facts:

The later and greater portion of the expansion is performed with saturated mixture. When a saturated mixture expands adiabatically, performing work, there is a heavy transfer of heat from the steam to the air in the mixture, as is clearly demonstrated by the temperature curves shown in Fig. 3, which is reproduced

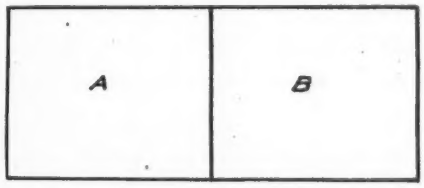


FIG. 2. AIR-STEAM VOLUME DIAGRAM

from February issue of Practical Engineer. One cubic foot of steam at 50 lb. pressure expanding to 10 cu. ft. drops from 280 deg. to 150 deg., but 1 cu. ft. of compressed air at 50 lb. pressure expanding to 10 cu. ft. drops from 280 deg. down to 165 deg. below zero.

Thus the final temperature of the steam alone is 150 deg. above zero, while that of the air alone is 165 deg. below zero, and the difference is 315 deg.

If this initial cubic foot of steam and this initial cubic foot of air were intimately mixed, and then, performing work, expanded adiabatically to the same extent, at the end of the expansion it would be utterly impossible for the steam to retain a temperature of 150 deg. above zero while the air in the mixture sank to the frigid temperature of 165 deg. below zero. It must follow that the temperature of the air cannot grow so extremely cold while intimately mixed with this very hot steam.

Conclusively, then, the steam transfers a large amount of heat to the air in the mixture during the entire period of expansion. This means practically the reheating of the compressed air throughout the entire expansion, and the high economy of reheating compressed air is fully set out in Chapter XVII of Richards' book on Compressed Air.

Why Steam Gives Up This Transferred Heat

In a saturated mixture, this transfer of heat from the steam to the air in the mixture is clearly a transfer of the latent heat of the steam, and it is the same latent heat which otherwise is lost in the exhaust steam of the present steam engine.

The proof of this last fact is found in a careful study of the properties of saturated steam. These five properties are pressure, temperature, heat of the liquid, internal latent heat and external latent heat, and all are given in Steam and Entropy Tables by Professor Peabody.

A pound by weight of saturated steam at 167.3 lb. absolute pressure, and a pound by weight of saturated steam at 25.9 lb. absolute pressure, respectively possess properties as shown in the table.

Thus the difference in heat between the first pound of steam and the second pound of steam is only 38.2 B. t. u.

But, when the first pound by weight of saturated steam at 167.3 lb. absolute pressure, performing work, is expanded adiabatically down to 25.9 lb. absolute

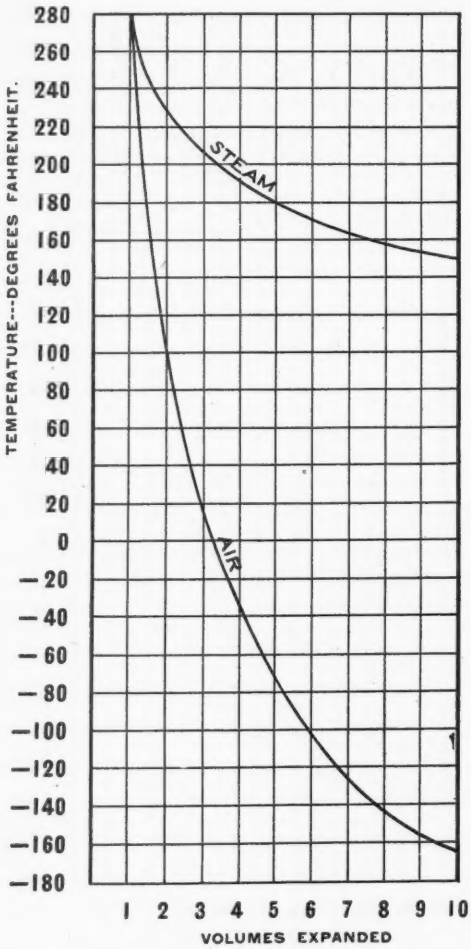


FIG. 3. STEAM AND AIR TEMPERATURE CURVES

pressure, it converts the difference between 1194.0 and 1054.8 or 139.2 B. t. u. of heat into work, as shown in Peabody's tables; hence, this pound of steam must give over to the work the total of 139.2 B. t. u. of heat.

But the difference between the first pound and the second pound is only 38.2 B. t. u. of heat, and this is not enough to perform the work represented by 139.2 B. t. u.

Then the difference, 139.2 — 38.2 or 101.0 B. t. u. of heat must be supplied from some of the above properties of this steam; but, what particular properties contribute and what properties do not contribute to this demand?

The first 3 properties of saturated steam, the pressure, the temperature and the heat of the liquid, all sustain an absolutely fixed relation to each other, and it is impossible for them to contribute any of the additional heat demanded for work.

But the 2 properties, internal latent heat and external latent heat, do not sustain any fixed relation to the other 3 properties, and, by condensation, can contribute any part or all of the latent heat of the steam to any and to all additional demands for heat. In fact, a pound by weight of saturated steam, can give up all of its latent heat, while the remaining water may retain all of the other 3 properties unchanged; as in this case, pressure 25.9 lb., temperature 242 deg. and heat of liquid 210.7 B. t. u.

Conclusively, then, in a saturated mixture of air and steam, performing work, expanding adiabatically, all heat transferred from the steam to the air in the expanding mixture is latent heat of the steam. In a proper mixture of air and steam, fully 50 to 60 per cent of the latent heat of the steam can be utilized.

The chief merit of this system is that it has the effect of giving a noncondensing engine all of the ad-

PROPERTIES OF HIGH AND LOW-PRESSURE STEAM

	PRESSURE IN LB. PER SQ. IN	TEMP FAH	HEAT OF THE LIQUID	INTERNAL LATENT HEAT	EXTERNAL LATENT HEAT	TOTAL HEAT
FIRST	167.3	367.0	338.8	771.4	83.8	1194.0
SECOND	25.9	242.0	210.7	870.3	74.8	1155.8
DIFFERENCE			+128.1	-98.9	+9.0	+38.2

vantages of a condensing engine without the necessity of a condenser and without water for condensing purposes. This statement is clearly demonstrated by the fact that the working area on the indicator card lies entirely above the atmospheric pressure line.

All that has been said of the air-steam mixture is likewise true of any mixture of neutral gas and vapor with positive latent heat.

This is practically a new field of research, and the mixture of vapor and neutral gas may be applied in several new systems of motive power. In fact, the Christie Engine Co. of Marion, Iowa, has already devised 3 separate and distinct systems to utilize the mixture, and all will be tested in the near future.

One of the leading railway companies of this country is now building a monster air-steam locomotive with compound tandem cylinders and 10 drivers, to be completed in September, the results on which will be reported in Practical Engineer.

IT IS ESTIMATED BY H. M. Wilson, chief engineer of the Technological Branch of the United States Geological Survey, that the damage inflicted every year in the United States by smoke is more than $600,000,000, due to destruction of merchandise, defacement of buildings, tarnishing of metals, injury to plant life, and the greatly increased labor and cost of housekeeping. This statement is based upon estimates made by Chicago with $50,000,000 per year, Cleveland with $4,000,000, and a number of other cities, which means a loss of $20 a year to every man, woman, and child in these cities.

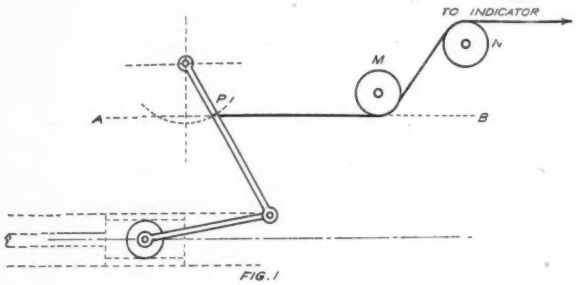
THE EFFECT OF SOOT on the evaporation of a horizontal tubular boiler is shown by some trials made in which during the first series, soot was allowed to remain on the tubes and in the second series, the tubes were cleaned in the morning. With the soot allowed to accumulate the evaporation from and at 212 deg. per pound of dry coal was 6.2 lb., the dry coal per square foot of grate surface 13.4, and the temperature of the escaping gases 627 deg. F. With the tubes cleaned, the evaporation from and at 212 deg. per pound of dry coal was 7.04 lb. of water, the dry coal per square foot of grate surface per hour was 9.09 lb. and the temperature of the escaping gases 546 deg.

THE CARE AND USE OF THE INDICATOR

By John Lucien Jones

THIS article is not presented as an exhaustive treatise on the steam engine indicator, but is merely a collection of practical points, more or less connected, on matters which are constantly appearing to the up-to-date operating engineer who makes use of his best friend, the indicator.

In the preparation for a certain job, the first thing to consider is the spring to be used. A spring should



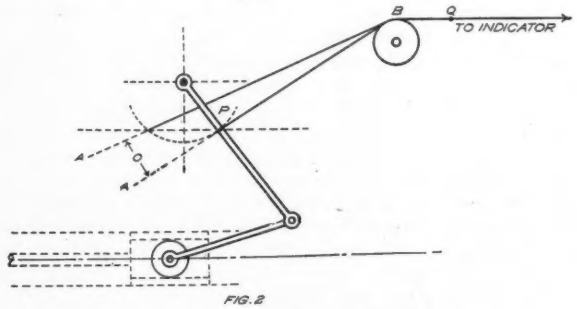


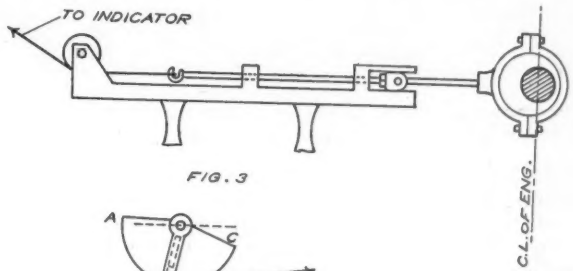
FIG. 1. COMMON FORM OF REDUCING RIG
FIG. 2. INCORRECT FORM OF RIG

never be compressed enough to give a card more than 2 in. high. The height should usually be less than this, otherwise the spring is liable to acquire a permanent distortion, and not return to its original position when the pressure is relieved. If this happens, the spring must be calibrated before attempting to get reliable results from it.

From the steam gage determine the maximum pressure likely to occur in the cylinder of the engine, and divide this by about 1.8 to get the proper scale of spring to be used. For example, if the gage reads 90 lb. as a maximum: 90 divided by 1.8 equals 50 lb. per square inch. Use a 50-lb. spring, which will give a card not higher than 90 divided by 50, or 1.8 in. Do not use a 50-lb. spring for pressures much over 100 lb. per square inch.

After the scale of spring has been decided upon, the next consideration is the length of the card. This varies, practically inversely as the speed of the engine. For a high speed engine about the longest card desirable is 3 in. If a longer card is attempted, unless the drum spring is very tight, the card will be distorted due to the inertia of the drum, which will stretch the cord. A somewhat longer card can be used for a low-speed engine, but the limit is usually reached at about 4 in., and this for very low speeds.

A good method of obtaining the proper drum spring tension is to set up the indicator and run the engine, loosening the drum spring until the cord flaps, then tightening until the flap is all taken up. The pull of the cord varies as the square of the speed, and is different in different parts of the stroke. Even though



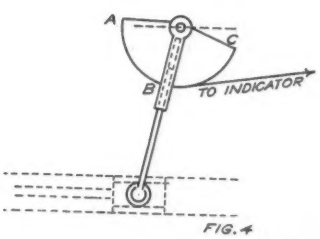


FIG. 3. REDUCING RIG EMPLOYING AN ECCENTRIC
FIG. 4. CAM REDUCING RIG

a perfect reducing motion is used, if the drum spring is too loose, considerable distortion of the card will occur. On the other hand, if the spring is too tight it will cause undue wear and tear on the instrument. The spring should be as slack as the speed of the

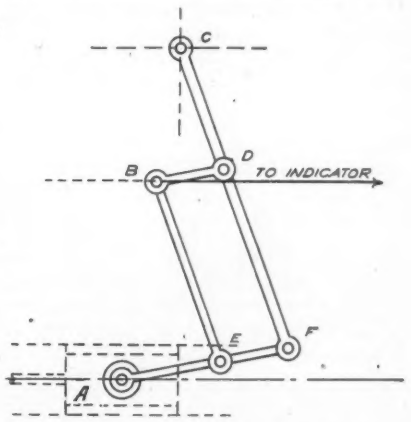


FIG. 5. PANTOGRAPH RIG

engine will permit in order to minimize the stretch in the cord and the wear on the instrument.

Cord

Standard indicator cord should always be used. This is a special woven braided cord furnished by the indicator manufacturer. It is stretched before being sold, by having weights hung on it to take out as much of the initial stretch as possible, which would produce distortion in the card. If a long cord must be employed, use for the largest part piano wire, which stretches but little under the ordinary drum spring tensions in use. Narrow flat steel bands are often used for this purpose.

The cord should always leave the reducing rig in a direction parallel to the center line of the engine, excepting where an eccentric rig, similar to that shown in Fig. 3, is used, or one which winds the cord on a cam or pulley. After leaving the rig, however, it can

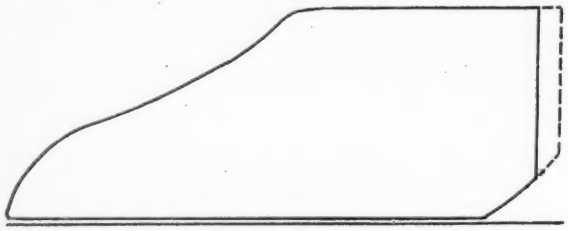


FIG. 6. CRANK-END CARD WITH TOO LONG A STRING.

be led in any desired direction. A short cord, of course, is best.

In Fig. 1 is shown a common form of reducing rig which, while it will not give an exact reduction of the motion of the piston, will give a close approximation if it is so designed that the oscillation of the point P

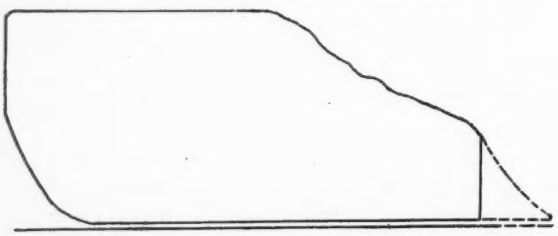


FIG. 7. HEAD-END CARD TAKEN WITH STRING TOO LONG

is equally above and below the line of the cord, AB, which is parallel to the center line of the engine. The pulleys M and N permit of the motion being led off in any direction desired. If, however, AB is not parallel to the center line of the engine, the conditions of Fig. 2 obtain, from which it is readily seen that the

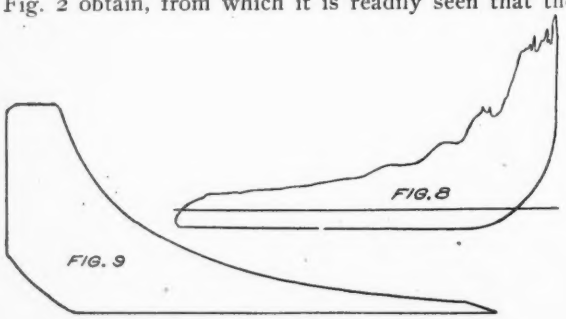


FIG. 8. EFFECTS OF USING TOO LIGHT A SPRING
FIG. 9. INDICATOR PISTON LOOSE FROM SPRING

movement of the point Q will not be proportional to that of the piston on account of the distortion introduced by the angle O.

Reducing Rigs

Primarily, a reducing rig should have as few joints as possible. It frequently happens that a geometrically accurate reducing motion has many joints which, soon or later, wear and introduce lost motion with consequent distortion of the card. Therefore, practically, an approximate rig, if well made, is usually more satisfactory, and less expensive, than an elaborately made one.

A good rig, where the use will warrant the expense, is an extra eccentric added to the shaft, having a throw equal to half the length of the desired card. This can be set exactly in phase with the crank and therefore gives a close approximation to the movement of the piston. A rig of this kind is shown in Fig. 3.

In Fig. 4 is shown a rig which has a pulley ABC, which is not the arc of a circle, but is a cam so designed as to correct the distortion caused by the rest

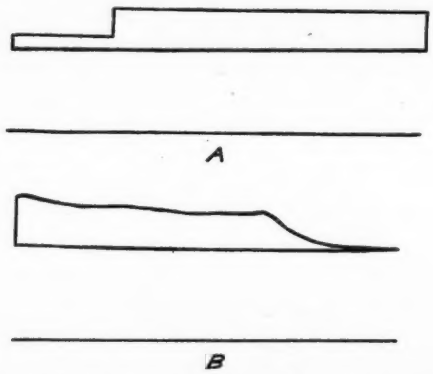


FIG. 10. ENGINE RUNNING WITH EXHAUST VALVE CLOSED

of the rig. If well made, this is a fine rig; it can also be arranged for use as a wrist pin oiler.

The pantograph rig, Fig. 5, needs no special discussion. It belongs to the class, previously mentioned, of geometrically accurate, but many-jointed rigs. The necessary conditions for obtaining a proportionate motion of B and A are that B always remains on a straight line joining A and C, and that

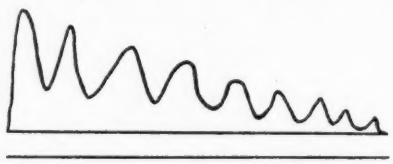


FIG. 11. PISTON DISCONNECTED FROM SPRING

BD equals EF, and BE equals DF; the reduction of motion is then as BC is to AC.

Method of Checking a Reducing Rig

The best and easiest method of checking up a reducing rig is to divide the stroke of the engine into a number of equal parts, say 20, by making small scratches on the engine frame near the crosshead. Make a mark on the crosshead, when the engine is on dead center, corresponding to the first mark on the engine frame. Set up the indicator as usual but omit the spring.

Turn the engine in the direction in which it is to run until the mark on the crosshead comes into coincidence with each of the marks on the frame in turn. Continue this for a complete revolution of the crank. In each of the 40 positions make a vertical mark on the paper by moving the pencil up or down. By measuring the distance between each two successive lines the amount and exact position of the error of the rig can be determined.

Use of the Indicator

In rigging up the indicator it is well to put a loop on the cord leaving the drum, and a hook on the cord

leading from the reducing rig. Many indicators now in use have a friction clutch, which makes it unnecessary to hook and unhook the cord for each card. Also, many reducing rigs are designed to operate in a similar manner by means of a suitable disengaging device..

When more than one indicator is to be used on an engine the cards should be taken simultaneously. This is especially so when 5 or 6 or a greater number are to be used, as on large pumping or marine engines, in which case a special electrically operated device should be used to press all the pencils against the drums at the same instant. The atmospheric line should always be taken, although it is not always needed or used.

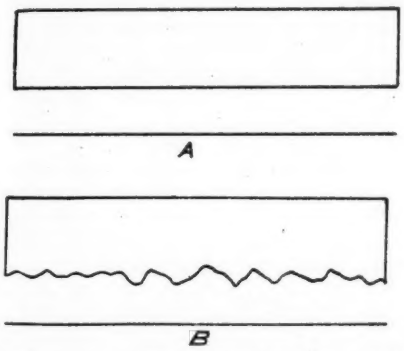


FIG. 12. CARDS TAKEN WITHOUT INDICATOR SPRING

The best lead to use is a hard or medium lead with a sharp point, with the pencil stop set so that there is just enough pressure to insure a firm, even line. Too much pressure on the pencil point produces considerable error due to the friction of the lead on the paper. It also is quite likely to damage the pencil motion by distorting its alignment. The pressure on the pencil point should always be adjusted before starting the job.

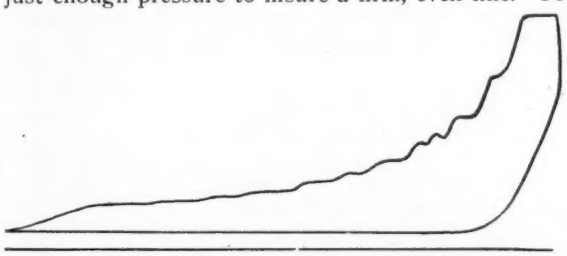


FIG. 13. INSUFFICIENT LUBRICATION

Lubrication and Care

The indicator, being a delicate and carefully made instrument, should have the best of care, if accurate results are desired. Before using, the pencil motion should be oiled with the light watch oil provided by the manufacturers for this purpose. The piston should be lubricated with a good grade of cylinder oil, free from grit, having a flash point higher than the temperature in the engine to be indicated, so that there will be no danger of the oil charring and scratching the cylinder walls.

After being used, the indicator should be dried carefully and inspected to make certain that it is in perfect condition. Great care must be used to keep grit out of the cylinder. Most indicators are furnished with a cylinder liner, which serves the double purpose of providing a steam jacket and a method of thoroughly cleaning the instrument. Also, if the liner becomes scored, it can be replaced cheaply and easily.

Some Distorted Cards and Their Causes

If a card is found to be distorted or unusual in any way, the first thing to do, before drawing any conclusions as to the working of the engine, is to examine carefully the indicator throughout and then the reducing rig. It will probably be found that the indicator has been improperly assembled or set up and that some part has worked loose, or that the pencil motion has been bent or damaged in some way.

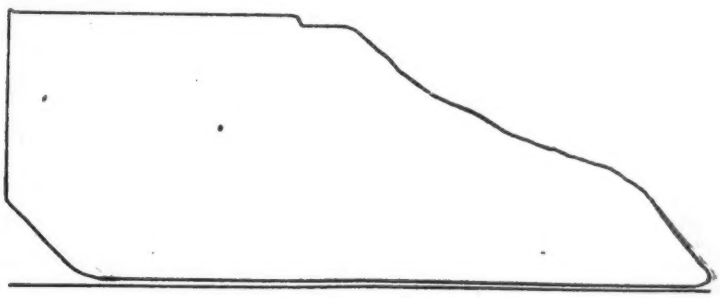


FIG. 14. MAXIMUM SIZE CARD

For example, if a gas engine is being tested, and the explosion line cannot be made to become vertical, it is most probable that the drum has not been seated properly, but is on crooked, making all the vertical lines slant. The way to test for this is to remove the spring from the cylinder, make a horizontal line on the card by pulling the cord and holding the pencil stationary. Then, holding the drum stationary in various positions of the stroke, move the pencil up and down, making vertical lines on the card. If these lines are all straight, and all perpendicular to the horizontal line first drawn, the drum and the pencil motion are all right, and the trouble must be located elsewhere.

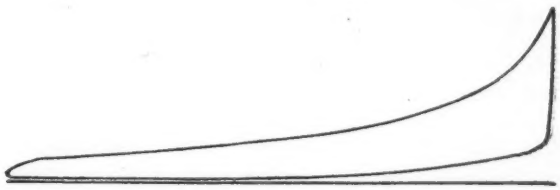


FIG. 15. CARD FROM GAS ENGINE

Figures 6 and 7 show the results of having the string too long. The diagram is on one end of the card and the pencil slides up and down on the drum, making a vertical line, as shown. If too short, the cord will be broken.

When a light spring is used on a high-speed engine, the inertia of the piston, rod and pencil motion is considerable. This makes the expansion wavy, as shown by diagram, Fig. 8, taken from a 6.5 by 10 in. Harrisburg engine running at 330 r. p. m.; a 60-lb. spring being used, in a Crosby indicator.

If it happens that the piston becomes loose from the spring it is shown on the card as a high exhaust line, apparently denoting a high back pressure. See Fig. 9, which is from a Porter-Allen engine running at about 140 r. p. m.

A high exhaust line may be the result of another and quite different cause, not at all the fault of the

indicator, as shown by Fig. 10, A and B, which were made on the above-mentioned Harrisburg engine by trying to run the engine with the exhaust valve closed.

When the piston has worked loose enough to become disconnected from the spring, the card shown in Fig. 11 is liable to be the result.

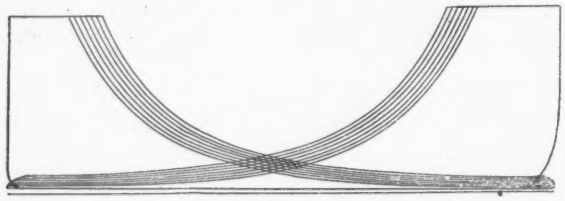


FIG. 16. EFFECTS OF GOVERNOR ON CONSECUTIVE CARDS

The use of the indicator without the spring produces the results shown in Fig. 12, A and B.

An expansion line which looks like a stairway is produced by insufficiently lubricating the indicator piston. This makes it stick until the pressure has dropped 5 or 6 lb., when it again sticks until the pressure drops the same amount, and so on. This effect is shown by the diagram, Fig. 13, which was made from the same Porter-Allen engine as diagram, Fig. 9.

About the maximum size card desirable, even with a slow speed engine, is shown in Fig. 14. It was also made from this Porter-Allen engine, with a 50-lb. spring; the engine running 145 r. p. m. The card is 4.5 in. long and 1.5 in. high.

Fig. 15 shows a fair sample of a gas engine card, made from a Springfield engine. And Fig. 16 is introduced to show the action of the governor on a Hamilton-Corliss engine; it also shows poor valve setting.

REMINISCENCES OF AN ERECTING ENGINEER

Preparing to Begin

By M. E. P.

AT first I thought I would draw from the experiences of others so as to keep the personal pronoun out of these talks, but I have been surprised to find that there is nothing published that would furnish any material from which I could draw. Whether this is due to the innate modesty of the erecting man or whether he feels the subject of his work and experiences is too big for casual discussion, "I dunno." In any case, the fact remains that there is little or nothing written by the men who install the numberless engines which the shops of the country turn out each year. Because this is so, I shall make no further excuse for the use of the personal pronoun and shall use it as often as I please and you will have to stand it as best you can.

I am going to preface these talks with just a few words about the usual procedure when a man is selected to go out on an erecting job. As he comes in from completed work, he is usually sent into the shop to work until his turn comes to go out on a job. The rule is that the man longest in is the first to go out unless some particular reason forbids.

A letter is received in the office saying that an engine has been received, that the foundation is ready and they want a man at once to get the work started. Word is sent to the man selected to report at once to the office and he is given his instructions. He is also told all that the firm knows about the purchaser, any details as to his treatment of men that have formerly been sent, or whatever other information the firm may have concerning him. This is not the least important part of the instructions that the erecting man receives, as it gives him something of an idea of the man he is to meet.

After the interview in the office, he goes to the drafting room, gets a full set of blueprints of the engine and then packs his tool box and sees that it is shipped. Right here is a chance for him to use a little judgment and possibly save the company a few dollars. If the engine be rather large and the preliminary work heavy, he can have his box sent by freight, but if he is sure he will need that box within a few days after he gets on the job, it will be the best plan to have it expressed or sometimes checked as baggage.

After his box is attended to, he gets an expense check, says good-bye to the shop for a time, and catches the first train for the scene of his operations. On arriving in the town where his work is to be done, he sees the purchaser at once, if that be possible, and in any case he should inquire the location of the plant, as his location of a hotel will depend on this—he will always stop as near the plant as he can and be comfortable.

The first interview with the purchaser often decides the degree of success which the erecting man attains in his work on a given job. It determines his status and, if the impression he leaves is bad, he will find it difficult and sometimes impossible to correct this impression. In some cases the trouble will grow to such dimensions that the firm will have to call him home and send another man to take his place, which is always bad for him. Tact and the ability to read men and adapt himself to the particular circumstances in which he finds himself is one of the best assets that an erecting engineer can have and he must cultivate his natural talent in that line as much as possible.

I remember an incident that occurred not long after I took a position with an engine company that I will call Blank. I had just come in from my first job and brought with me a letter of acceptance of the engine I had erected that contained some sentences rather complimentary of my work and the way I had overcome certain difficulties encountered. Naturally I was feeling a bit set up over it and turned my letter into the office with some little pride. Mr. Blank smiled and congratulated me on my success and took occasion to hold me in conversation for a few minutes. While we were talking, the oldest man on the road in point of service came in just off a job and said that he had to leave the next morning for the south, as some engines he had been at work on were ready for steam.

While we were passing the time of day, a message was handed Mr. Blank from the people where X. (the old man) had been. It read: "Send a man at once. Why did your man leave? Engine pounds so hard we can't run." Mr. Blank handed the message to X. and asked him what about it. "Oh, I knew she wouldn't run; her foundation is all gone and she jumps all over the plant, but I wasn't going to stay there to fight with them." "Well," said Mr. Blank, turning to me, "I guess it is up to you; there isn't a man in the shop now, so you had better go and see what is troubling them."

"I asked X. what was the matter with the engine and he laughed and told me I would find out when I got there. Mr. Blank explained that the job had only been the putting on of a new high-pressure cylinder and that the engine was an old one that had been in service for several years and had always given more or less trouble. He further informed me that they

were a ticklish firm to handle and were inclined to make it rather disagreeable for the erecting man.

I caught a train that day and arrived on the job the next morning, and sent in my card to the proprietor. I was shown into his office and almost the first words from him were, "What in ——— do your people mean by leaving this engine in such shape? Do you think we are a lot of ——— fools here, or what do you take us for?" And so he went on for a good 5 min. Hot? Well, I never saw a man any madder than he was. I didn't open my mouth, but let him talk as much as he wanted to, and it seemed to come to him all at once that he was doing all the talking and I all the listening. He shut up quick enough then and I got a chance to ask him what seemed to be the trouble with the engine. He said he did not know, simply that they could not run her, she pounded so. He sent for the master mechanic and introduced me and told him to take me out into the engine room and let me see the engine.

We walked out and on my way I put a few questions to the M. M., but he would not give me the least bit of information. When we got in the engine room I was introduced to the chief and I asked him about the same things, but he was equally reticent, so I concluded that it was up to me to find out for myself. I asked the chief to give the engine steam and let her roll over as fast as he dared, and he did so.

When she got up to about half speed she sounded as if someone was inside of her cylinders with a sledge and was working it for all he was worth. I went into the basement and looked around her foundation and walked up the stairs again and told them to shut her down. I then told the M. M. that I was ready to go back to the office and see the boss. On the way back he tried to get my opinion as to the trouble, but I was pretty mad myself by this time and I didn't give him any information.

When we got into the office I told the proprietor that I had found the trouble and that it was not the engine that was at fault, but the foundation which was broken. There was another scene between the boss and the M. M. and it was a hot one. I kept out of it and let them have it out between themselves, but you can rest assured that I wished myself anywhere else but just there. At last the boss turned to me and asked what could be done to remedy the trouble, and I told him. Various suggestions were made for patching, but I refused to consider any of them, as the trouble in this case was too serious for patches to do any permanent good.

After a long discussion they came to my way of thinking and then it was a question of the time it would take to do the job. I made an estimate and also offered to put on 2 or 3 gangs and keep the work going night and day until it was completed. This was finally done and the engine put into service, where I am glad to say that she is running now without a bit of trouble.

There were several times during the course of the work that I had to show my authority and insist on having certain things done as I wanted them, but when the job was completed and the engine finally put on the regular load and I got a release, I was given a letter to the firm at home that made me prouder than the first one I took in. When I left, the proprietor shook my hand and said that they had never had such good satisfaction during the years they had been in business, etc., etc.

Well, the whole moral of this story is simply that a man must know how to keep his temper and also how to stand up for his rights when it is necessary. You have got to show a proper respect for those in authority and demand a like respect for yourself. Neither of these is obtained by servility or by demand. A quiet, dignified, yet genial, demeanor will get you along anywhere.

After arriving on a job and seeing the purchaser, the erecting man's first duty is to find his engine. If it be on the cars and has to be hauled to the plant, he should make arrangements for the hauling, unless that has been done by his firm, as it sometimes is. It is usual to let this work by contract and hold the contractor responsible for all the labor and damage incident to this part of the job. The foundation must be examined carefully and he should be sure that it is properly built and of sufficient weight for the engine.

I have known of instances where the builders would be perfectly justified in demanding that a new foundation be built or that they be released from all responsibility for the satisfactory running of the engine because of a foundation that was not heavy enough to carry the weight that was to be put upon it. There must be no question in the mind of the erecting man that the foundation will do its work when the engine is put in commission, so he inquires closely into the character of the bottom and the depth of the excavation. The importance of all of this is obvious and needs no comment.

While the hauling of the parts is going on, the erecting man keeps a watchful eye on the workmen to see that no unnecessary risks are taken, and if he thinks necessary, helps the contractor with advice which his knowledge of the engine will qualify him to give. He sees that the parts he will want first are delivered so as to be easiest of access. The hauling will call for considerable ingenuity at times and some of the most interesting experiences that an erecting man has are in connection with this work.

I once had the erection of 2 engines in New Orleans, 27 by 54 by 42 in. vertical, cross-compound, running at 120 r. p. m., and when hauling 1 of the low-pressure cylinders we had a rather lively experience that is a good illustration of the things one is likely to meet in the course of his work. The sewerage of some parts of New Orleans consists of open gutters at the side of each street, and where streets cross, the gutters are bridged with cast-iron plates. These plates are supported on I-beams and are strong enough to carry ordinary traffic—but our traffic was unfortunately a little extraordinary.

We had safely passed several of these crossings and had our 10-mule team trotting along at a lively gait when we swung around a corner and came a little too close to the edge of one of the crossing plates and in an instant down went the back wheel of the truck clear to the hub. The cylinder was chained to the truck, but it broke loose and over it went and took the corner out of a porch in front of a drug store and went through the sidewalk, which was of brick, and made a hole about 18 in. deep in the sand and mud on which the walk was laid. Things happened for a few minutes, but it only took about an hour to get the cylinder back on the truck and get started again.

The cylinder was not damaged except for the breaking of 5 or 6 of the studs and those in such a way that they were easily removed. It cost something to repair the crossing plate, the porch and sidewalk, but the contractor never murmured at the expense—he was too glad that he didn't have to pay for a new cylinder.

ONE AND ONE-QUARTER BARRELS of cement and ¾-yd. of sand will lay 100 ft. of rubble stone.

GAS ENGINES AND PRODUCERS

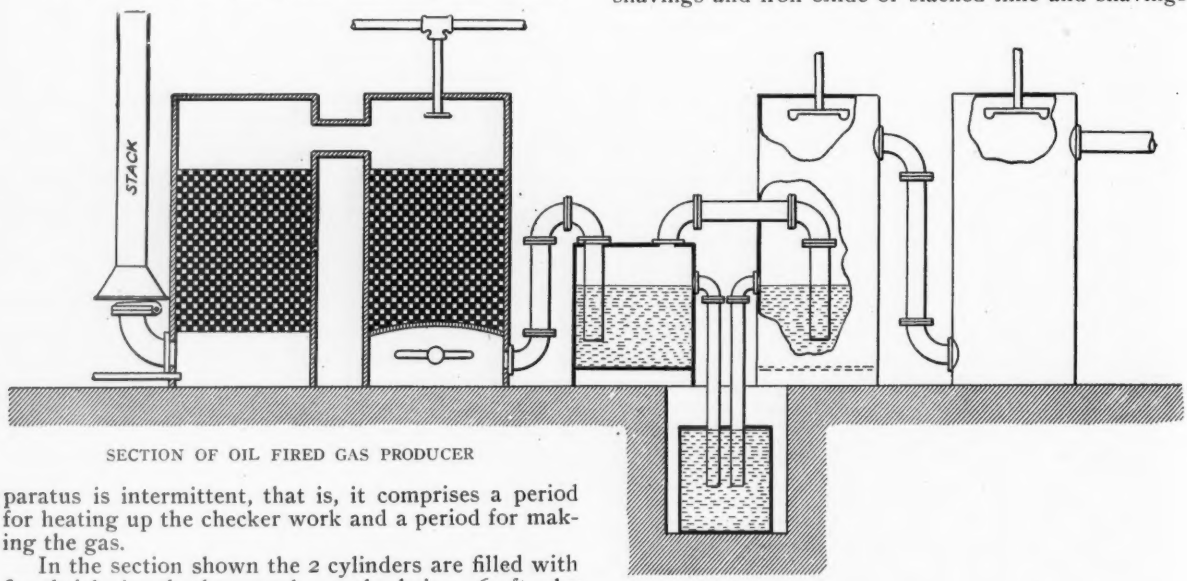
THE CRUDE OIL GAS PRODUCER

IN many parts of the southwest, coal is scarce and crude oil is plenty and it is found desirable to make a producer gas from the crude oil for use in lighting and in gas engines. Several systems have been devised for this, one of the best being the Lowe system which works on the same principle as the blast stove in a blast furnace for melting iron ore.

Two cylinders are provided which are filled with a checker work of fire brick which is heated up until it has reached a high temperature and then through this checker work crude oil is sprayed, mixed with superheated steam, thus giving a gas which is purified by washing.

Apparatus

It is evident that the production of gas in this apparatus is intermittent, that is, it comprises a period for heating up the checker work and a period for making the gas.



SECTION OF OIL FIRED GAS PRODUCER

In the section shown the 2 cylinders are filled with fire brick in checker work, each being 6 ft. by 12 ft. and lined with fire brick outside the checker work filling. In 1 of the cylinders, a fire box is placed in the bottom and the checker work is supported above this on an arch. Into this box the crude oil is blown by air pressure and burned in a crude oil burner, the products of combustion passing upward through the checker work in this cylinder and across the connection down through the checker work in the second cylinder and then to the stack. At the bottom of the second cylinder which is shown at the left is a steam pipe and at the top of the first cylinder is a nozzle pipe through which steam and oil are supplied.

Operation

When heating up the checker work, the crude oil blast in the fire box is started and the waste gases are allowed to escape up the stack until the checker work is heated. When the brick has reached a bright red heat, the oil blast in the fire box is shut off, the escape valves in the stack closed to prevent any air from entering the producer and the jet of superheated steam and air is turned into the top of the first cylinder passing down through the checker work, while steam enters the bottom of the second cylinder and passes up through the checker work in that cylinder.

A mixture of oil and water is by this means converted into a water gas and this forced by the pressure over into washer, where the dust and the tarry product are removed. These rise to the surface of the water and are carried off by the overflow. The gas passes over from the washer into the scrubber which has water in the bottom and has the top filled with brush or wooden block work with a water spray at the top; from this tank it passes on to the condenser which is similarly filled with brush or wood and has also a water spray. The object of these 2 tanks is to remove all dust and tarry products or heavy oil so as to leave a clean gas. From the condenser, the gases pass through boxes which are filled with a mixture of pine shavings and iron oxide or slacked lime and shavings to further purify the gases and take out any acid gas which may be contained.

Heating up the checker work and sending through the blast to form gas take about the same amount of time for the 2 processes, and as the process is intermittent a gas holder must be used in which to store the completed and purified fuel gas. The results from a test run show that for each 1,000 cu. ft., about 9.37 gal. of oil were required, 1.71 gal. being required in heating up and 7.66 gal. in making the gas. Each gallon of oil weighs about 7 lb. and has a heating value of 19,000 B. t. u. and the gas as made has the heating value of about 650 B. t. u. per cubic foot. The periods of heating and making were each about 10 min.

FOR MUFFLING THE EXHAUST from a gas engine, a convenient device may be fashioned from an old house hot water tank by cutting open the top and bottom of the boiler for the exhaust pipe and outlet and putting tees on the end of the pipe, so that the exhaust will not flow straight through.

FROM THE GAS ENGINE EXPERT TO THE STEAM ENGINEER

By R. B. White

THE steam engineer had never had experience with a gas or gasoline engine and naturally was skeptical in regard to the new machine. It was a 4-cycle gasoline engine, but the same principles applied to it as to a gas engine and the maker's expert was explaining the points of running it. Of course he had found out how to start and stop, as the expert had told him to read the manufacturer's instruction book through carefully several times and cautioned him about draining the cooling water out of the cylinder jacket, and told him about oiling each part, using only gas engine cylinder oil on the piston and other moving parts such as the valve and igniter.

As the buyer was a steam engine man the expert drew his illustration from the standpoint of a steam engineer as much as possible and brought out the following:

In order for this engine to run there are 3 things necessary—(1) a spark, (2) fuel and (3) compression. All gasoline engines will run if these 3 things are right and no gasoline engine on earth will run with 1 of these essentials wrong. You would not expect a steam engine to run with no fire under the boiler, so don't expect this engine to run with no spark in the cylinder. You would not expect a steam engine to run if some one struck a match and threw it into the boiler firebox, when there was no fuel in there to ignite, so don't expect a spark to start your combustion engine when there is no fuel in the cylinder to ignite; likewise you do not expect your steam engine to run when there is a big hole in the boiler and no steam pressure; don't expect this engine to run without compression. The fuel mixture must be compressed otherwise it will fail to ignite and, if it did ignite without being under compression, there would be no power.

In many respects the gasoline engine is like a steam engine. Both get their power from expansion behind the piston. In the case of the steam engine you make use of an expanding vapor, which is conducted from the boiler to the engine cylinder, there to press against the piston, and in turn develop power. In the gas or gasoline engine the furnace is in the cylinder of the engine, directly behind the piston.

Instead of kindling one fire in the morning for all day, in the gas engine we kindle a new fire for each impulse of the piston. In a "4-stroke cycle" engine running at 250 r. p. m. we would therefore kindle or make 125 separate fires a minute. We have to kindle a new fire for each 2 revolutions of the flywheels.

We make use of 1 piston stroke for sucking in the charge, another for compressing this mixture, and while under compression the charge is ignited by an electric spark; this burning charge drives the piston out on its working stroke, at the end of which the exhaust valve opens and on the next stroke backwards clears the cylinder of the burned gases in order to make room for a fresh mixture which is taken in on the next outward stroke and the same operations repeated.

All gases double either volume for each 273 deg. F. we raise the temperature under atmospheric pressure. In the combustion engine the temperature of the gases behind the piston at the moment of ignition is near 1,900 deg. F., about that of molten iron; the high temperature has a tendency to expand the gases behind the piston to about 6 times their original volume, and this is where the gasoline engine gets it power. Every heat unit retained by the expanding gases means just so much power delivered to the piston; every heat unit absorbed by a cold or porous cylinder means just so much fuel wasted; every heat unit that passes through a hole or leak in the cylinder (poor fitting piston rings, leaky valves or gaskets) means just so much power lost. Hence, the importance of a good cylinder with well-fitting rings and properly seated valves; in other words, good compression.

There are some other things I failed to tell you, and the most important one is that a gasoline engine will not ignite, if you give it too much fuel. Too much gasoline is worse than none at all.

If the first 4 or 5 rounds do not start it, more cranking only tends to make it harder to start, because cranking does not fix anything and every round adds more gasoline to the engine cylinder, so that when you do get the real cause fixed you will have a flooded cylinder, and of course more turning will not start the engine.

All beginners have to learn not to flood the engine. Very often they forget to put on the battery switch until they have cranked the engine awhile. Then they discover their mistake and put on the switch, but more cranking fails to start the engine because the cylinder got flooded before there was a spark to burn the gasoline. The greatest difference between an expert and a novice starting an engine is that the one is careful not to flood the cylinder, whereas the other has yet to learn by experience.

When you suspect that your engine has too much gasoline, shut off the needle valve to prevent more getting in, open the air damper wide, leave the battery switch on, and turn the fly-wheel over 10, 15 or 30 times and the surplus gasoline will work out through the exhaust. If very badly flooded, take out the igniter; open one or both of the valves, and relief cocks if any; strike a match, and hold it at or in the ignitor opening. This will set fire to the gasoline in the cylinder and burn it out. When doing this, stand away from in front of the hole and keep the hand with the match in it to one side, because, when ignited, a blaze of fire 2 ft. long will shoot out of the cylinder. The object of opening up the valves and vent cocks is to give the fuel air so that it can burn. Remember that air is just as important as gas in order to get an ignition in an internal combustion engine. You do not expect the fire under a boiler to burn when all the air dampers are closed tight.

Remember there are 3 things necessary for any gasoline engine to run and if it does not go either the gasoline, spark or compression is at fault, and the first thing to be done is to determine which of these 3 things is wrong.

First, examine the compression by turning the flywheel over; if hard to turn and rebounds when turned loose, the fault is not with the compression. It must be with the fuel or the spark.

Next test the sparking mechanism. In the make and break igniter only 2 tests are necessary to see whether this part is right. First, with the switch closed and circuit breaker open, take a piece of metal of any kind, with one end of it touch the insulated post of the igniter, and with some other portion of it touch the other igniter post. If on breaking the contact with one of the posts a good spark (as large as a grain of wheat) is seen, it shows that the battery and connections are all right. If no spark is secured, the trouble is with the battery or connections.

Look for loose connections somewhere in the elec-

tric circuit, especially in or on the battery switch. Examine also for rusty, dirty or corroded contacts. Broken wires, imperfectly insulated wires, sparker points stuck in contact, or a completely exhausted battery will cause you to fail to get a spark with this test.

While it shows that the battery and connections are in good working order this is not conclusive evidence that there is a spark being made in the cylinder. The second test is applied to see if the igniter is all right and is as follows:

Raise or move the igniter trip until the sparker points come in contact inside the cylinder. (By listening you can hear them come together.) While the points are in contact, or while the trip is in position that they should be in contact try with a piece of metal for spark as before. If you got a spark in the first test and fail to get a spark in this test, it shows that the igniter is right because the current is going through the points which accounts for not getting a spark now.

Should the points be corroded, or dirty, or not making a good contact on account of the movable electrode being stuck, we would get a spark on making this test; hence, if we get a spark on applying this second test, look for igniter trouble. Take it out and fix it.

After trying these 2 tests to the igniter and the 1 test for compression and finding them right, the trouble must be with the fuel mixture.

Three tests will determine whether the engine is taking gasoline: First, see that gasoline is pumped up into the carbureter supply cup; second, see that the opening under the needle valve is not clogged; third, see that the intake valve is not stuck.

These 3 features being right the engine is obliged to take gasoline. None of these tests would, however, indicate that the engine is flooded or that the air intake pipe was stopped up, either of which might cause the engine to refuse to start.

The 3 necessary requisites for a gasoline engine to run apply to an engine as it is always shipped by the makers with valves and spark properly timed. It is possible, in an old engine, that someone has changed the time for the spark to be made; the sparker should trip at a point near the end of the compression stroke. The only way that the valves could get badly out of time—that is, sufficiently to prevent the engine from starting—would be for someone to take the valve gear cog wheels off and fail to put them back with marked cogs in mesh; hence, see that the marked cogs on this 2 to 1 gear are in mesh.

It is barely possible that water is in the gasoline, or on the sparker points, or that kerosene has been mistaken for gasoline, any of which would make the engine balk at starting.

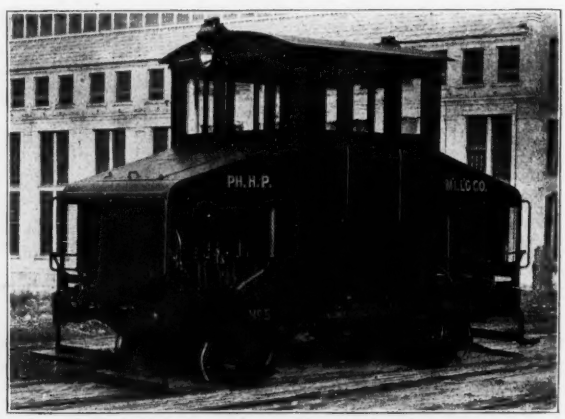
After all, gasoline engine experting is simply close observation, confidence in yourself and the engine, and plain horse sense. Most of the engine troubles we hear of are more the operator's fault than the engine's. Study your engine when it is working well in order that you may know how each piece does its part. In case of trouble, be sure to locate and fix it because it gives you confidence and enables you to do it easier next time.

WHEN DISCHARGING A BROADSIDE of 8 12-in. guns the Dreadnought of the British Navy, which is a vessel of 18,500 tons, slid sidewise several yards and listed heavily. Each of these guns is 53 ft. long and fires a shell weighing 850 lb. at a muzzle velocity of 2000 mi. an hour, using a charge of 265 lb. of cordite.

A GASOLINE LOCOMOTIVE

FOR switching freight cars in the yards of industrial plants, it is not always convenient to await the convenience of the railroad, nor is the business often large enough to warrant maintaining a steam yard locomotive. Electric locomotives are costly and necessitate expensive overhead wires which are likely to be in the way, or else still more expensive storage batteries. Compressed air has been used to some extent, but the air must be at high pressure or it will have to be frequently replenished, and this involves a special air compressor plant; also the loss of air at the high pressure is considerable.

For the plant of the Postel Milling Co., at Mascoutah, Ill., a gasoline locomotive has been built under the supervision of Postel and Linn, consulting engineers of Chicago. This is a 12-ton machine, standard



GASOLINE LOCOMOTIVE FOR SWITCHING

gage, with 30-in. driving wheels with steel tires; the total height is 10 ft. 6 in., the width 6 ft. 6 in., the wheel base 8 ft. 6 in. and the total length 16 ft. Under test it gave a draw bar pull of 4,000 lb.

The gasoline engine has 3 vertical cylinders 9.25 by 11 in. and runs at 400 r. p. m. The cylinders are cast separately with solid heads, having valve cages bolted to the cylinders on each side, which makes replacement of the valves easy. Splash oiling in the crank case and a force feed oiler insure thorough lubrication. Two methods of ignition are provided, a storage battery and a magneto.

The main frame of the locomotive is rectangular in shape, the sides being of 10-in. steel channels and the ends steel castings. The sub-frame is of cast iron having bolted to it 2 steel channels which project forward to support the main frame.

Operation of a reversing lever in the cab serves to start the locomotive in either direction as may be desired, the speed being 6 miles an hour with the engine running at 400 r. p. m.; this speed can be decreased considerably at will by the timing of the spark. Both front and rear axles are connected to the countershaft by chain drive and cast steel sprocket wheels with cut teeth, the bearings for the shaft and transmission being of bronze.

Cooling water is carried in a tank at the end of the locomotive opposite the engine. This water tank has a capacity of 200 gal., the circulation being maintained by an Imperial pump. On the inside of the cab are 2 10-gal. gasoline tanks so fastened to the subframe that they must be removed for filling. Braking

is by hand, the brakes being compound and acting on all 4 wheels. The brake and clutch handles are interlocked so that setting the brakes releases the clutch. The coupling devices which are of the M. C. B. type and so arranged that they can be coupled to cars standing on a curved track having a radius of 150 ft. can be operated from the cab by a system of roads.

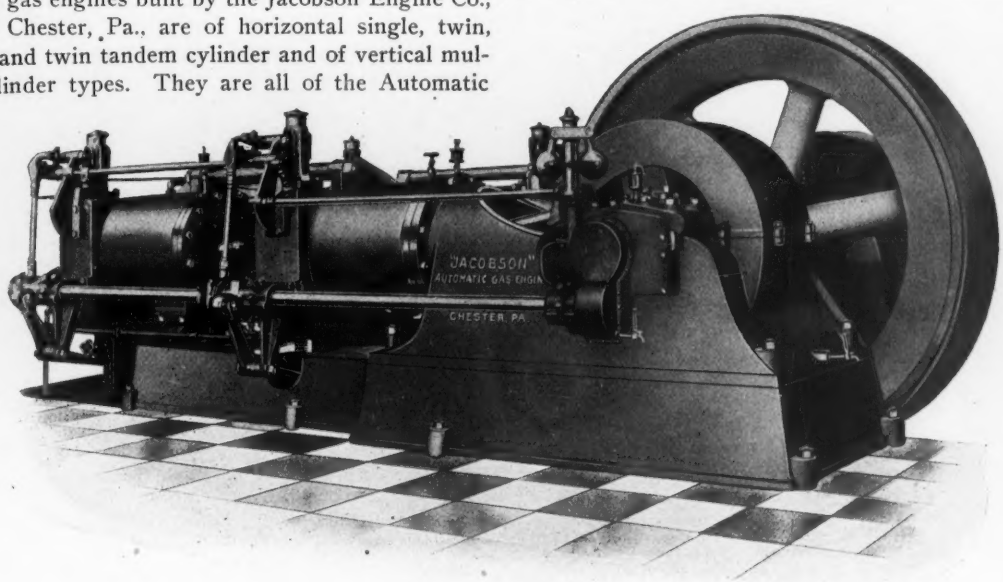
A whistle operated by the exhaust from the engine is provided, also headlights.

Cost of fuel ceases, of course, as soon as the engine is shut down, and it can be started again at a moment's notice. Meantime the engineer is free to assist about other work. As to the maintenance cost, it has been found to be from $7 to $8 a day, which includes the cost of fuel, oil, engineer's wages, interest and depreciation on the cost of the locomotive; this operating cost is based on a 10-hr. day. The machine can be started quickly for the setting of a car whenever desired, and may safely be run into shops, as there is no danger from dropping of coals or flying sparks.

The locomotive was built by the Milwaukee Locomotive Mfg. Co., of Milwaukee, Wis.

THE JACOBSON AUTOMATIC SCAVENGING GAS ENGINE

THE gas engines built by the Jacobson Engine Co., of Chester, Pa., are of horizontal single, twin, tandem and twin tandem cylinder and of vertical multiple cylinder types. They are all of the Automatic Scavenging type, and are built in powers from 20 hp. upward for use with any gas or gasoline. Among other details in perfection of design, the cylinder bushings and other wearing parts are renewable, thus reducing repairs to a minimum in time and money, and perpetuating the life of the engine.



JACOBSON AUTOMATIC SCAVENGING GAS ENGINE

The valve mechanism is of interest because of its importance in controlling the power and in regulating the turning effort of the engine, and is pre-eminently a striking feature in gas engine design. The gas and air come to each cylinder separately in a manifold pipe, the gas being above; the gas valve is mounted on the air valve spindle, but sliding freely and held against its seat by a spring between the valves. The cams are set so that the air valve opens just before the closing of the exhaust valve, and the momentum of the exhaust gases in the exhaust pipe creating a suction effect on the clearance space of the engine, pulls through the flushing or scavenging charge of air. A set collar on the valve spindle then comes into action, fully opens the gas valve and the piston moving forward sucks in its charge.

This scavenging action of the valve mechanism admits of high compression and consequent high economy; pre-ignitions do not occur because the heat in the cylinder is kept at a minimum, nor are back-fires possible for the mixing of gas and air takes place at the valve entrance to the cylinder. The governor automatically trips the valves at any point of the stroke as determined by the load on the engine, giving the graduated impulse required by the best gas engine practice.

The perfect system of governing and scavenging, together with the entire absence of back-fires and pre-ignitions, make this engine particularly adapted for direct connection to electric generators or for any purpose where evenness of torque is a factor desired.

For use on producer gas these engines have been found to be especially noteworthy because the high percentage of hydrogen sometimes prevalent in this gas makes trouble all the more persistent; in fact, the Jacobson Engine Co. has had such success with producer gas engines that its main business consists in contracting for complete producer gas power plants, guaranteed by it as a unit, using what in its opinion is the best producer made for the special purpose in hand.

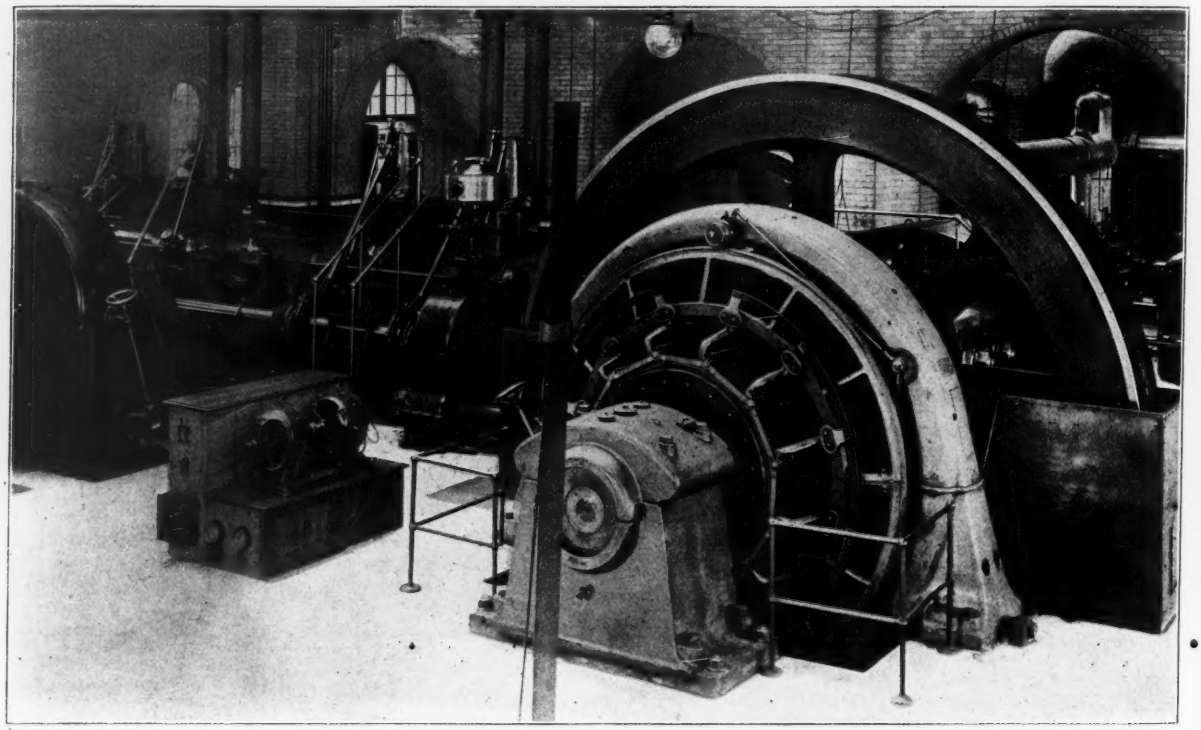
A QUICK REPAIR METHOD for small pipe is given by a correspondent who is a woodworker. Having a pipe about 3 in. in diameter, he got from a carriage maker an axle clip and yoke which was bent around the pipe and put over the hole with a piece of rubber packing about an inch in diameter between the clip and the pipe. When the clip was screwed up, the leak was stopped and held tight for several years.

WHEN IT IS DESIRED to avoid rust or discoloration, a soldering fluid may be made of 2 oz. of alcohol, 3 oz. glycerin, and 1 oz. chloride of zinc crystal.

GAS ENGINE INSTALLATIONS AGGREGATING 210,000 HORSEPOWER

In the accompanying illustration is shown an Allis-Chalmers horizontal, double-acting tandem gas engine, of 500 hp., driving a direct-current generator of the same company's build in the power house of the Illinois Steel Co.'s Bay View Mills at Milwaukee, Wis. During the 2 yr. this has been in operation, the unit has not cost $50 for repairs, and its record has been such as to demonstrate conclusively the reliability of gas engines, properly designed, for industrial service of the most severe character.

Machines in operation for about the same period of time, or longer, include gas engines and generators of from 300 to 5,000 hp. capacity, which, with others now going into commission, furnish power for iron works, steel mills, clay products plants, cement mills, automobile shops, plate glass works, tube mills, wire works, central power, lighting and traction stations, phosphate plants, factories and other industrial establishments. In the list are engines operating on producer, natural and furnace gas and their capacity for continuous service aggregates no less than 210,000 hp. Among the larger users of gas power in the industrial field is the Pittsburg Plate Glass Co., which was one of the earliest to install the improved type of engine and electric generator built by Allis-Chalmers Co., and has just placed an order for the eleventh of these units.



ALLIS-CHALMERS GAS-ELECTRIC UNIT IN ILLINOIS STEEL CO.'S POWER PLANT

THE NARRAGANSETT ELECTRIC LIGHTING CO., Providence., R. I., are installing 4 440 hp. B. & W. boilers with corresponding 6-retort Taylor stokers which they will operate at practically 900 hp. normally. These boilers will, during a peak load, probably be run at about 1,200 hp.

GAS ENGINE PROGRESS *

THERE is no doubt in our minds that the gas engine as a power generator is reliable and a success, but the local conditions must be thoroughly studied before its installation can be recommended.

Producers

Producers are now on the market that can gasify successfully even the poorer grades of fuel such as have not been successfully handled under steam boilers; and instances have been noted where the coal utilized contained excessive quantities of moisture and as high as 25 per cent of ash. Yet the least difficulty is met with the best grades of coal and when available at a fair cost, they are the most economical. The smaller the percentage of ash, the less is the tendency to form clinkers, and this also facilitates getting the best results. Semibituminous coal, lignite, peat, wood and charcoal are being successfully handled in more than one type of producer.

Action of Different Coals

Although the quality of gas varies with the grade of fuel and the method of operating the producer, the fixed carbon is a basis of producer action and for the yield of gas. Bituminous coal having 20 per cent volatile matter works satisfactorily, but strongly caking coals are apt to be objectionable owing to the difficulty of keeping a brisk fire. The pea size is considered the best in anthracite, but the cheapest is No. 1 buckwheat with a low percentage of ash. Much fine dust is objectionable in anthracite and great trouble is sometimes experienced in trying to gasify culm, and the poorer grades of buckwheat.

*Extracts from the report of the National Electric Light Association Committee.

For up draft producers finely divided fuels lying compacted should be avoided, as they necessitate a heavy blast, which carries much of the small dust over into the gas connections. Besides that this fine fuel tends to close the firebed and creates a high back pressure. A large amount of ash reduces the capacity of the producer and gives a tendency towards clinkering, especially if the ash contains any amount of sulphur.

Roughly, the gas may be estimated at 70,000 cu. ft. a ton when wood is used, up to 150,000 cu. ft. when coal is used, and a possible 200,000 ft. a ton with a pure carbon such as coke or charcoal. In the table

TABLE. COAL ANALYSES AND PROPERTIES

COAL	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	SULPHUR	B.T.U. PER POUND
			ANTHRACITE			
ANTHRACITE PEA	1.34	5.94	76.65	16.07	1.26	12,540
MOCANASUA, PENN'A	2.95	7.14	69.44	20.47		11,344
GLACIER CREEK WASH	2.70	5.00	86.80	4.40	1.10	13,700
MADRID, NEW MEX.	2.80	3.00	87.60	5.60	1.00	13,400
CANADIAN, NEAR WASH.	0.90	9.30	77.40	11.30	1.10	12,815
			BITUMINOUS AND SEMI-BITUMINOUS			
PITTSBURGH RUN OF-MINE	2.16	32.08	55.03	10.76	0.95	13,145
POCAHONTAS, W. VA.	0.80	18.30	73.65	7.25	0.57	15,682
BRAZIL, IND.	8.98	34.49	50.30	6.28	1.39	14,542
CAMBRIDGE OHIO	2.43	37.79	50.36	9.42	3.01	14,474
TABER COAL, WASH.	9.00	29.80	50.20	9.70	1.30	11,580
BIG MUDDY, ILL.	5.55	27.20	53.01	14.24		11,900
MADRID NEW MEX.	8.20	35.20	53.00	8.30	1.30	12,702
			LIGNITES			
COLO. SIMPSON MINE	20.24	32.26	41.65	5.85	0.60	9,767
TEXAS-HOYTE	33.71	29.25	29.76	7.28	0.53	7,348
SOUTH AMERICA	18.0	40.0	31.0	9.0	3.5	
SAMPLES FROM-						
EIGHT STATES, AVERAGE	26.6	31.4	32.6	9.53	1.29	8,350
CENTRALIA, WASH.	21.50	36.80	29.60	10.70	1.40	11,253
" B, "	20.00	5.80	32.20	35.00		7,700
" D, "	17.80	9.70	48.70	23.80		8,000
			PEAT			
PEAT	21.00	51.73	22.11	5.17	0.45	8,127

are given the characteristics of several coals from different parts of the country, but these cannot be taken as indicating the value of all coal from their respective sections.

Producer Gas

Three methods of making gas are used: Raising the temperature of the fuel bed so that the volatile matter is driven off, leaving a bed of fixed coke as in ordinary coal gas manufacture; raising the temperature of the fuel bed to burning point and cutting down the air supply so that only part burning takes place and much of the carbon is driven off as carbon monoxide; raising the fuel to white heat and admitting water vapor so as to cause the carbon in the fuel and oxygen in the water vapor to unite, giving carbon monoxide and hydrogen in the gas. The first method is practically not used in the making of fuel gas; the second one is the one most commonly used in making producer gas and the third is the water gas process. Water gas is sometimes enriched by the addition of oil gas vapor for city use, but not when used for engines.

With the up-draft type of producer it is necessary to use some method of keeping the fire at a temperature which will not burn up all the fuel, and this is accomplished by the use of steam or carbon dioxide in the air blast. With down-draft producers the incandescent coal in the lower part of the fire bed tends to change the carbon dioxide into carbon monoxide; with intermittent operation, steam is added periodically and in the continuous operation steam is mixed with the air admitted, thus controlling the temperature of the fire.

In the gas will be found from 70 to 85 per cent of the original heat available in the coal. Radiation is the cause of the principal loss.

For nonbituminous coals the up-draft producer is ordinarily used, with some means of forcing the air through the fuel, such as a blower or steam jet. If this type be used for bituminous coals the heat in the top of the fire tends to carry over the tarry products and hydrocarbons in the gas and makes a dirty gas which is difficult to clean. The method usually used

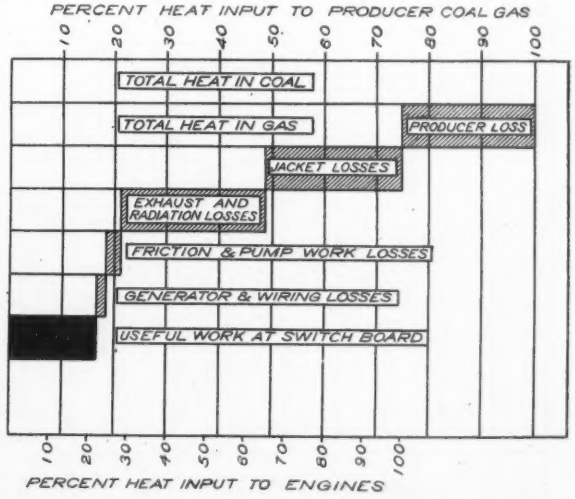

PERCENT HEAT INPUT TO PRODUCER COAL GAS
10 20 30 40 50 60 70 80 90 100
TOTAL HEAT IN COAL
TOTAL HEAT IN GAS
PRODUCER LOSS
JACKET LOSSES
EXHAUST AND RADIATION LOSSES
FRICTION & PUMP WORK LOSSES
GENERATOR & WIRING LOSSES
USEFUL WORK AT SWITCH BOARD
10 20 30 40 50 60 70 80 90 100
PERCENT HEAT INPUT TO ENGINES

FIG. 1. HEAT DISTRIBUTION AND LOSSES IN GAS PRODUCER AND ENGINE PLANT

for cleaning is passing the gas through a cold water shower or spray which condenses much of the tar, but will not take all of it out.

In the down-draft type of producer the action is the same as in a down-draft boiler furnace, the air coming down through the fuel bed, which is incandescent at the bottom. When using this type, the fire

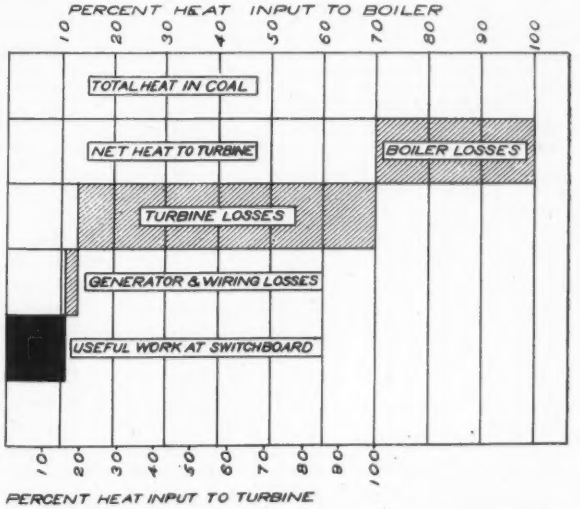

PERCENT HEAT INPUT TO BOILER
10 20 30 40 50 60 70 80 90 100
TOTAL HEAT IN COAL
NET HEAT TO TURBINE
BOILER LOSSES
TURBINE LOSSES
GENERATOR & WIRING LOSSES
USEFUL WORK AT SWITCHBOARD
10 20 30 40 50 60 70 80 90 100
PERCENT HEAT INPUT TO TURBINE

FIG. 2. DISTRIBUTION OF HEAT IN STEAM PLANT, BOILER AND CONDENSING TURBINE.

bed must be kept uniform, as blow holes which may form will allow the tarry matter to get through, making a dirty gas.

Double Zone Producers

The double zone is a combination of the down draft and up draft, the gases passing down through

one fuel bed and up through the second. Fuel is usually fed at the top and the gases pass down through the upper layer, leaving this layer with considerable hydrocarbon, which is mixed with producer gas and leaves coke. The coke falls to the lower zone through which the up draft comes, air and steam vapor being admitted below the bottom zone. In this way the hydrocarbons from the upper zone and the water gas from the lower zone are mixed and pass on to the scrubber. When properly proportioned and operated this should avoid the formation of tarry products, and only the solid particles and dust need be removed from the gas. A definite time contact must be provided in the coking zone in order to take out all the volatile matter, and arrangements must be made for regulating the supply of air and steam to the 2 zones in order to get the right mixture in the center of the producer.

Gas Engines

The foundations are built rigid and considerably heavier than those of steam engines, and are practically proportioned to the weight of the reciprocating parts.

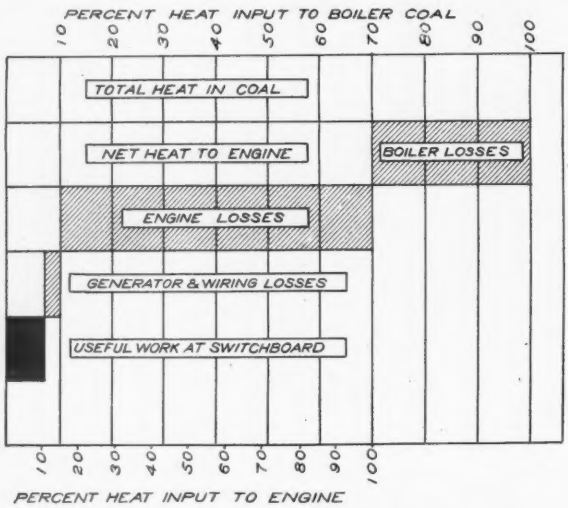

PERCENT HEAT INPUT TO BOILER COAL
10 20 30 40 50 60 70 80 90 100
TOTAL HEAT IN COAL
NET HEAT TO ENGINE
BOILER LOSSES
ENGINE LOSSES
GENERATOR & WIRING LOSSES
USEFUL WORK AT SWITCHBOARD
10 20 30 40 50 60 70 80 90 100
PERCENT HEAT INPUT TO ENGINE

FIG. 3. HEAT DISTRIBUTION IN STEAM BOILER AND NON-CONDENSING ENGINE PLANT

In erecting gas engines, care should be taken to provide the exhaust line with expansion joints or to provide for movement without breaking any of the connections, as the high temperatures of exhaust produce a considerable expansion which must be taken care of. The distance may be large between the producer and the gas engine, as there is practically no loss in energy by transmitting the gases for some distance.

The committee recommends the use of a cooling tower for handling the water where water is scarce.

Large engines usually have 2 sets of igniters in different positions in the cylinder combustion space so that both may be used, thus making ignition almost certain.

Positive forced lubrication has overcome many of the early difficulties experienced with gas engines. An oil pump is usually used and the oil piped from the single large pump or from a series of small pumps to the different points on the top of bearings, and the oil timed to fall on the piston between the piston rings when on dead center.

Gases

Producer gas as usually formed contains 50 to 70 per cent nitrogen and has a heating value of 90 to 160 B. t. u. per cu. ft. Natural gas has a heat value of about 1000 B. t. u. per cu. ft., which is from 8 to 10 times greater than producer gas. The report of the committee states that it is possible to get 3 times as great a power value from natural gas used in gas engines as it is when using the natural gas under steam boilers. Coke oven gas is produced in the manufacture of coke, about 6000 cu. ft. being thrown off per ton of coal carbonized. The heat value of this depends upon the method of operating the oven and is from 500 to 700 heat units per cubic foot.

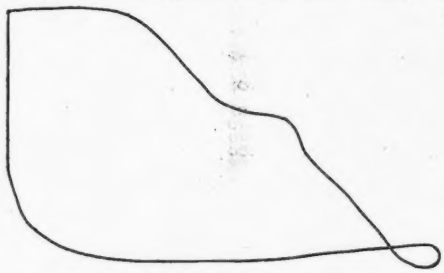
A MASSACHUSETTS EXAMINATION

By J. C. Stewart

1. What is wrong with this card, and how would you make it right?

2. Draw a card showing the admission valves of a Corliss engine leaking, and one of the exhaust valves leaking.

3. What effect has it on a cross-compound engine if the valves of the high-pressure are leaking?



IRREGULAR INDICATOR DIAGRAM

4. If the receiver pressure is too high, what effect has it?

5. What would you do to equalize the work done in both cylinders?

6. How would you change the speed of a Corliss engine?

7. Draw a card of a high-speed engine, showing the valve leaking.

8. A simple slide valve engine and an automatic cutoff engine, both the same size cylinders, run at the same speed, doing the same work. Which would you prefer and why? Is there any difference in horsepower?

9. Where does the steam cut off in a pump, and can the valve motion be made to cut off in an ordinary pump any earlier in the stroke? How?

10. For a triple-expansion engine draw a card showing the intermediate admission valves and exhaust leaking.

11. What effect will it have on the low-pressure cylinder?

12. What effect on the low-pressure if the valves are leaking?

13. In a Corliss engine, what determines the point of cutoff, and how does it do it?

14. In an automatic cutoff engine, what determines the point of cutoff, and how does it do it?

15. If you want to change a Corliss engine from noncondensing to condensing, what would you do with a single eccentric and with a double eccentric?

16. Suppose the steam cuts off too late in the high-pressure cylinder, what effect will it have on the low-pressure? Draw a card showing it.

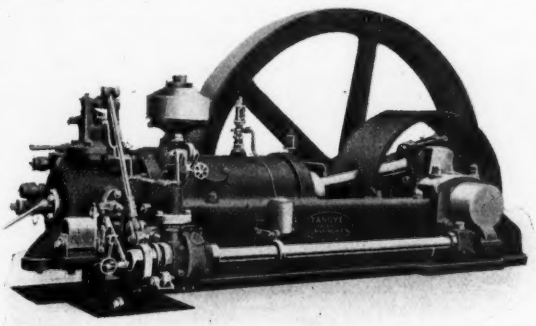
LONDON LETTER

New Gas Engine Models

By W. A. Tookey

STIMULATED by European competition, and particularly from German makers, there is to-day a decided tendency towards redesigning the British types of gas engines so as to include, not only all the improvements that the experience of many years has shown to be desirable with regard to economical working and general efficiency, which appeals to the man who buys, but also with respect to the technical thoroughness which ensures the ready appreciation of the man who takes charge, and finally, but a matter certainly not of the least importance, to reducing the cost of manufacture which interests the man who sells.

Hitherto, the German and British types of gas engines have been quite dissimilar in general appearance. In the future it seems that it will need a much closer scrutiny before the country of origin can be determined, for not only are overhanging cylinders, a distinguishing British characteristic feature, being abandoned for a combined casting with the main frame, but governing by varying the lift of a common inlet valve to produce consecutive explosions of mixtures whose volumes are proportionate to the load, is replacing the "hit and miss" method once universally applied for all engines below about 150 hp.



TANGYE GAS ENGINE

Engine Frame

One of the most up-to-date engines is that recently brought out by the well-known firm of Tangyes Limited of Birmingham, and the illustration given here enables most of the leading features to be appreciated. It will be noticed that the bed of the engine is cast with the cylinder jacket, the latter being supported throughout its length. At the base of the frame, a lip is cast, to receive the waste oil that would otherwise flow over the foundation, and the engine being erected so that the center of the cylinder axis at the back end is about half an inch higher than the crank axis, all oil naturally flows to the front, where it is removed from time to time by means of a cock and draining tube.

The foundation bolts are carried through the girder type frame to above the longitudinal center line of the engine, tying the base to the foundation in a much more efficient manner than is possible when projecting side lugs are provided for the purpose. For the convenience of erection, and to avoid all chance of possible error on the part of the builders of the foundation, all the bolts are of equal height above the floor. Another detail, small in itself, but illustrative of the thorough manner in which the designer has dealt with practical considerations, is the provision for pouring in liquid cement from the top of the girder arms, so as to grout in the foundation bolts and firmly to key the frame to the masonry on which it rests.

Two flat-topped bearers are also cast in the crank pit to form a support for wooden blocks upon which the piston is received when removed from the open cylinder end for cleaning purposes, a convenience that will be greatly appreciated by those responsible for the general well being of the engine in everyday work.

Side Shaft

Both brackets carrying the side-shaft bearings are supported from the main frame, making it possible to dismantle the breech end without any interference with the governor or cams, while the bearings are provided with side covers instead of the usual solid bushes, so that the cam shaft can be removed without requiring the brackets to be detached. In the small sizes, the lubrication of these bearings is effected by wicks and tubes, but in the large, ring lubrication is resorted to, involving a minimum amount of attention, and reducing the quantity of oil required. The cams are of large radius with ample bearing surfaces to give smooth operation to the valve levers and quiet working.

Liner

The working cylinder is cast separately from the main casting and is made of specially hard material to resist wear. It is put in place from the back or breech end, a rubber ring being used to make the front joint, while at the breech end a circumferential lip fits into a machined recess in the main casting, and is held securely in position by the separate combustion chamber, thus dispensing with all liner bolts, as well as lugs projecting from the liner itself which have frequently been found to cause distortion and local strains with consequent trouble from leaky back end water joints.

In the older types of gas engines, it has frequently been found that, after several months of constant use, a ridge has been formed in the liner at the point at which the back piston ring reverses, the consequence being, that oil collects at this point and becomes carbonized forming an impediment to the free motion of the piston, giving rise to noisy working, and by causing the end piston ring groove to become wider, permitting the gas to blow by. Occasionally, similar ridges have been found to occur at the position coincident with the reversal of the front piston ring, while it is not unusual for attendants and repairers to encounter serious difficulties in the withdrawal of the piston from the liner due to this cause.

In the new engines, the liner and piston rings are properly correlated, so that the back ring of the piston projects slightly over the working portion of the liner, which is counterbored to prevent any ridge being formed. For exactly similar reasons, a piston ring is also included in front of the piston pin, so that, upon the extreme outstroke, a portion of the front ring projects slightly beyond the chamber formed at the open mouth of the liner. By such precautions, the length of life of the liner is greatly prolonged, while there is nothing that will encourage widening of the piston ring grooves, and therefore, the piston remains gas-tight for a much longer period.

The front piston ring really fulfills a double purpose, seeing that it acts very effectively as an oil distributor upon its backward movement. Wear of the nature described has long been a source of annoyance to many gas engine makers, as, somewhat naturally, they have been led to think that the wearing of the liner in ridges has resulted from inefficient lubrication when such has not been the case.

THE ABSORPTION SYSTEM OF REFRIGERATION

By Chas. L. Hubbard

IN this system the general principles are the same as in the compression system except the ammonia gas is changed to a liquid form without mechanical means.

The operation in its simplest form is shown in Fig. 1 in which A and B are 2 strong iron cylinders connected by the pipe C. Let A be partially filled with highly charged aqua ammonia and a spirit lamp or other source of heat be placed beneath it. Let chamber B be placed in a tank of running water, the temperature of which is kept at, say, 60 deg. As the aqua ammonia in A becomes heated the ammonia is vaporized, thus causing a high pressure, about 120 lb. per sq. in., in both cylinders. This pressure, which corresponds to that produced by a compressor, raises the boiling point of the water and therefore prevents its vaporization; C being surrounded by cold water

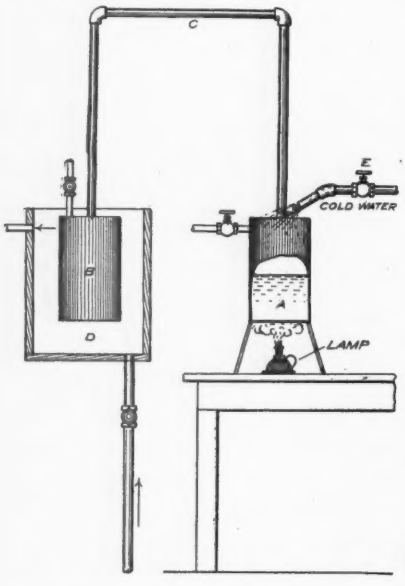


FIG. 1. PRINCIPLE OF ABSORPTION SYSTEM

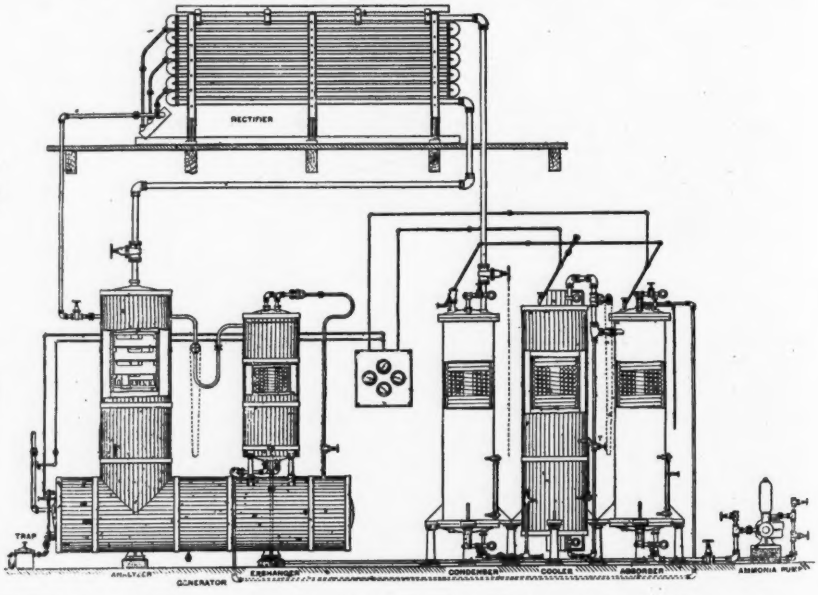


FIG. 3. TYPICAL INSTALLATION OF ABSORPTION SYSTEM

causes the gas, which is under pressure, to liquefy. After the ammonia has been separated from the water in A and condensed in B, the lamp is removed, the water drawn out of the tank D and the substance to be cooled put in its place surrounding B. Cold water is now turned on A through the pipe E, which cools it and removes the pressure from both cylinders. This drop in pressure causes the liquid anhydrous ammonia in B to vaporize, and in so doing absorb heat from the substance surrounding it.

As the expanded gas returns to the cylinder A and comes in contact with the water it is again absorbed, giving off its latent heat which is carried away by a stream of water from pipe E, thus completing the cycle. Figure 2 shows in diagram the different parts of an absorption machine which serve to show how the simple operation above described may be utilized under actual working conditions.

In this diagram the letters correspond to the following parts of the apparatus: A, steam heated generator, containing aqua ammonia; B, analyzer; C, rectifier; D, condenser; E, expansion valve; F, brine cooler; G, absorber; H, strong liquor pump; I, exchanger.

The operation, which is simply an elaboration of that shown in Fig. 1, is as follows: Steam is admitted to the coil in the generator A, which heats the aqua ammonia and causes the gas which is liberated to rise through the analyzer B to the rectifier C. This is surrounded by water at such a temperature that any water which is carried up by the ammonia in the form of a spray is condensed and drains back to the analyzer and generator through the pipe J. The temperature of the water surrounding C is not sufficiently low to condense the ammonia gas which passes from the top to the condenser D. Here it comes in contact with coils of water at a low temperature, and still being under the pressure of the generator is condensed to liquid form and falls to the bottom of the chamber D. From here it is admitted through the expansion valve E to the brine cooler F, the same as in the compression system, where it is vaporized and takes up heat from the brine passing through the interior coils. From the brine cooler the gas passes into the top of the absorber G, going back to the exchanger I. Weak liquor, so called, which is that remaining in the generator after the ammonia gas has been partially driven off, is drawn up through the pipe K by means of the strong liquor pump H; then passes through the coil in I and is delivered at the top of the absorber G, where it mixes with the ammonia gas entering from F and absorbs it and falls to the bottom of G as strong liquor. From here it is pumped back through the exchanger I and overflows into the analyzer B and is thus returned to the generator, which completes the cycle. As the comparatively cool strong liquor passes through the exchanger it is heated by the hot weak liquor within the coil, and as it falls in thin sheets over

the interior plates of the analyzer it gives up some of its ammonia to the rising gas, enriching it still further as it passes to the rectifier.

Figure 3 shows an absorption system as actually installed, the operation of which can easily be traced by a comparison with Fig. 2. These machines vary in construction and general arrangement the same as in a compression plant, and the condensers, coolers, and evaporators are practically the same in both.

Generator and Analyzer

The generator, or still, is usually made up of a horizontal cylinder containing the required number of steam coils for heating the liquor.

The analyzer is usually mounted directly above the generator, and is made in the form of a vertical cylinder with numerous trays over which the rich liquor trickles in thin streams as it passes downward to the generator.

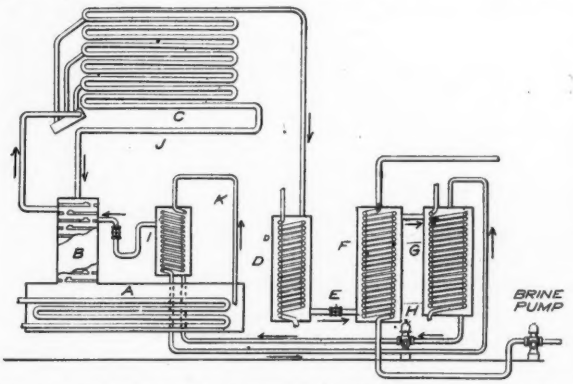


FIG. 2. CROSS-SECTION SHOWING OPERATION OF A COMMERCIAL ABSORPTION SYSTEM

Rectifier

This is similar to the condenser of a compression system and in large plants is often located on the roof.

In the case of small machines it is more commonly submerged in a tank of water located near the other apparatus. Sometimes it is made in the general form of a feed-water heater.

Condenser

This in principle is the same as for the compression system and the forms which have previously been described are used in this connection. In the machines illustrated in Figs. 2 and 3 the condenser is of the enclosed type similar to a feed-water heater.

Absorber

This is similar in construction to the enclosed type of condenser. The ammonia gas from the cooler enters the shell near the top and as it comes in contact with the weak liquor spray which also enters near the top, it is absorbed, thus changing the weak liquor into rich liquor. The heat given off by this process is carried away by water flowing through the enclosed coil.

Exchanger

This is commonly mounted directly above or near the generator. In the illustrations given it consists of a cylindrical shell containing an interior coil. The rich liquor passes through the shell while the weak liquor from the generator is drawn through the coil.

In some forms the exchanger is made on the 2-pipe principle similar to an ammonia condenser, the rich liquor passing through the inner tube in an upward direction while the weak liquor enters at the top and passes through the outer pipe in a downward direction, so that the 2 liquids exchange temperatures.

THE QUEER CASE OF A GENERATOR AND RECTIFIER FOR AN ABSORPTION ICE MACHINE

By W. S. Luckenbach

IT HAS been known to the writer for some years that cast iron rectifying pans used in connection with generators of absorption machines would deteriorate, and in the course of from 5 to 7 yr. become devoid of both tensile and torsional strength. I have seen instances where the lower pans were in such condition as to be crushed, by reason of being unable to sustain the weight of the entire nest of pans, and the iron could easily be cut with a pen knife, but I was not prepared for the condition of affairs found in the portion of these generator and rectifier shells.

The plant is 60 tons capacity, in 2 units of 30 tons each, and originally had 2 cast-iron generators and rectifiers for each machine. The generator and rectifier is in 2 sections bolted together and stands vertical, the ammonia boiler or generator being the lower and the rectifier the upper section. They are 30 in. internal diameter with metal 1.5 in. thick and were erected in 1891.

While the engineer, Mr. Lyons, was repairing 1 machine he noticed what at first appeared like a heavy mark made with a scriber and about 2 ft. long in the upper section. By a close examination it was found to be a crack and he at once dismantled this section; when upon getting inside, he found a large portion partially eaten away in line with the crack, and in such condition as to be cut easily with a pen knife to within 0.5 in. of the outer surface. It was then decided to make a new generator and rectifier entirely of steel.

Having thus escaped a serious accident, and as the other machine was kept in operation with the other 2 cast-iron boilers and rectifiers, it naturally put the engineer on guard and he made special examination daily. Soon after, and before the second steel generator and rectifier were finished, he noticed a similar crack in the lower section of one of the other cast generators while under 180 lb. pressure, and immediately commenced lowering the pressure in the usual way and shut the machine down.

Upon examination, the same defects had developed as described heretofore, and the point is that during all these years of constant use, it never occurred to either the writer or the owners to make an internal examination of the shell (largely due to the writer's knowledge of the thickness of the shell and that it was exposed to ammonia on one side only), and that it behooves all owners of absorbtion machines and engineers in charge occasionally to examine and analyze the internal portion of the generator whether constructed of steel or cast-iron and especially cast-iron.

The accompanying illustration shows the style of generator and rectifier now in operation capable of supplying gas for 1 30-ton machine with 99 per cent pure liquid ammonia; it was designed by the owner of the plant who is one of the pioneer absorption ice machine builders in the country, and has given entire satisfaction during the season of 1908.

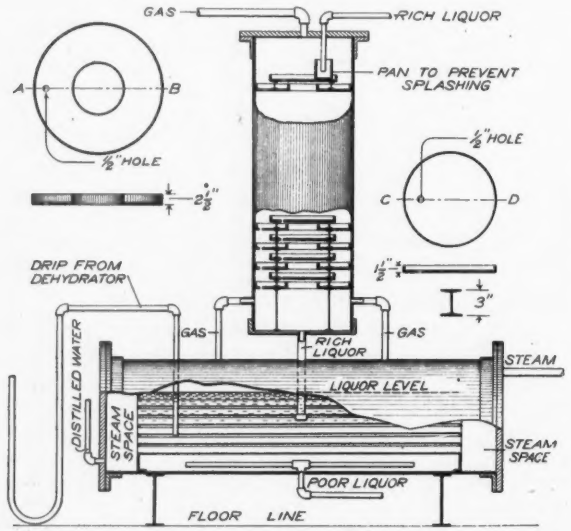
The generator has a steam space at each end and

is spaced full of tubes similar to an ordinary tubular boiler.

It will be seen that the rectifier is separate from the generator, hence it is not subjected to the same heat, as it has no connection with it except through the gas and rich liquor pipes.

Generator and Rectifier For 30-Ton Machine

The generator is 48 in. diameter by 14 ft. long over all with a flanged head 9 in. from each end for steam space. There are 90 2.5-in. by 12.5-ft. tubes so spaced as to leave 17 in. gas space when the tubes are properly covered with the rich liquor. The poor liquor pipe at the bottom is 1.25 in., extending about 4 ft. each way from the center; the ends of the pipes are



GENERATOR AND RECTIFIER SECTIONAL VIEW AND DETAILS OF PANS.

plugged and perforated. A 2.5-in. steam inlet enters the top of one end and the outlet to the distilled water tank is at the bottom of the other end. The rectifier is 46 in. diameter by 14 ft. high and is located central with the generator and about 2 ft. above it, with 2 3-in. gas pipes leading to the rectifier and entering it about 18 in. from the bottom. The rich liquor pipe is 3-in. and extends well below the liquor level in the generator, so arranged that the flow of rich liquor will not injure the tubes.

The large rectifying pans fit snugly the inside of the rectifier shell, and the lower large pan rests on supports 2 ft. from the bottom. It will be seen that all the large pans have an opening of 16 in. with an inside edge 1.75 in. high. The inner or small pans rest on short pieces of 3-in. I beam, leaving a space of 1.25 in. between the lip on the large pan and the bottom of the small pan which has a lip of 1.5 in. In the bottom of the small pan are again placed pieces of 3-in. I beam, leaving a space of 1.5 in. from the lip of the small pan to the bottom of the next large pan and continue in the same manner until the shell is filled in such a manner that the top pan is about 30 in. from the top head.

In the top pan is placed a pan about 10 in. diameter by 6 in. high to receive the rich liquor and avoid splashing. The rich liquor pipe is 2-in. and the gas pipe 3-in., located about as shown in the illustration.

Dehydrator

This is a spiral coil consisting of 175 ft. of 3.5-in. pipe submerged, and is located on the roof alongside of the atmospheric condensing coils, the drip (which is 1.25-in.), runs down to the engine room floor and enters the generator through the top thus forming a loop and extending down through the liquor far enough to allow it to have perforations double the area of the pipe, the end of the pipe having a welded plug. The perforations should be low enough so that, if the liquor should get low in the generator, they will still be covered, otherwise this drip from the dehydrator might eventually cause the exposed tubes to become pitted and leak; this caution also applies to the rich liquor pipe.

The idea of the loop in the dehydrator drip pipe is to form a trap and prevent any gas passing up the drip pipe to the dehydrator when starting up instead of passing through the rectifier.

Exchanger

The exchanger is of the double tube type and consists of 4-in. outside and 2.5-in. inside pipes. The advantage of using large pipes is that there are less return bends, less joints, less chances for leaks and less friction, which means less power both for the ammonia and water pumps. Poor liquor enters the outer pipes at the top and the rich liquor the inner pipes at the bottom thus the poor liquor from the generator on its way to the cooling coils imparts much of its heat to the rich liquor entering the generator.

Absorber

The absorber for 1 30-ton unit is 81 in. internal diameter by 10 ft. high, containing 8 circular coils of 2-in. pipe with cooling water passing through them, the largest coil being wound over a 72-in. mandrel.

Operation

These machines were operated during the entire season of 1908, making full capacity with the aqua ammonia never exceeding 24 deg. Beaume and weak liquor about 17; approximately 12 per cent distillation, the water for the condensing and cooling coils from 80 to 88 deg. F. and the distilled water entering the fore cooler at 90 deg. and the cans at 80 deg.; absorber pressure 5 lb., steam pressure 90 and generator pressure 180 lb.

It will be noticed that the distillation was only about 12 per cent and as it requires approximately 14 per cent distillation, it was found after a trial that better results were obtained by slightly increasing the speed of the ammonia pump than to distil the 24-deg. rich liquor to 16.

The reason that the distilled water entered the cooler tank at such a high temperature was, that the cooling coils in the distilled water tank were somewhat coated, hence less heat was abstracted from the distilled water, and the reason why it entered the cans at 80 deg. was due to the fact that, when the liquid ammonia passes the expansion valve, the gas expands into a vapor and absorbs heat and by the time it has passed through the expansion coils it has absorbed nearly all the heat it is capable of retaining; hence, when this vaporized gas enters the cooler tank it is incapable of absorbing much more heat.

In this particular case, however, it was immaterial whether additional heat in the distilled water was removed before entering the cans or afterwards; the fact remains that the machines made full capacity by reason of the purity of the liquid anhydrous. A larger volume of expanded gas would simply have resulted in a larger output because the return gas would have abstracted more heat from the distilled water when

passing through the cooler tank on its way to the absorber, and the value of lowering the temperature of the distilled water, say 10 deg. can easily be estimated when the reduction on a 60-ton machine would amount to 1,200,000 heat units, equalizing about 3 tons of additional ice per 24 hr.

The writer would again call special attention to the manipulation of the expansion valve, because much of the foregoing economy is due to its proper management. This valve should be so regulated that white frost beyond the expansion valve is barely noticeable; at this point the best results relative to the absorbtion of heat from the brine have been obtained. Change of pressure requires change of valve. The bath was easily kept at a temperature of 10 deg. above zero when making full capacity with distilled water at 80 deg.

Gas Receiver

An excellent adjunct to any ice machine is a liquid gas receiver or collector with absolutely self-closing water gages, as by that means the engineer can, in a great measure, regulate the volume flowing through the expansion valve.

Packing

There is probably no other one matter calling for the engineer's immediate attention, and at the same time more exasperating (because he knows his extra labor is more likely to decrease the output), than an irreparable leak of the ammonia or large water pump during the busy season, because it means expeditious work, and at best, the chances are that the brine will go up several points; hence, any method or material that will reduce the conditions to a minimum is most welcome to the engineer, to say nothing of the beneficial effect on his temper.

The packing of one of the ammonia pumps gave out on a Sunday morning and there was none to take its place. The engineer went to a nearby junk shop in quest of something, but found only an old rubber buggy tire; this he shaped nicely to fit the stuffing box, and it worked so well that he fixed the other 2 ammonia pumps and both large water pumps in the same manner. They ran the entire season of 1908 without additional packing and the cost for packing of the 5 pumps for the season was 45c to say nothing of the extra comfort of the engineer.

ECONOMY TESTS OF HIGH SPEED ENGINES

RECENTLY it became necessary to make tests of several different high speed engines, direct connected to electric generators, for the purpose of determining the quantity of steam used per indicated horsepower per hour, per kilowatt-hour, and to determine some other characteristics. This work was undertaken by F. W. Dean, of Boston, and A. C. Wood, of Philadelphia. The idea was to take the engines as they were found in order to ascertain their economy after having been run for some time, and to state as nearly as could be determined the number of hours that they had been in actual running service. It was not desired to do anything to improve the economy, or to remove any defects, except to equalize the work done at both ends of the cylinders, if they should prove to be unequal, by adjusting the lengths of the valve stems.

The results which are herewith presented in some detail in tabular form are both helpful and suggestive as a record of economy of relatively small engines after continuous use.

The engines tested had characteristics as follows:

No. 1, 15 by 14-in. at 240 r. p. m., horizontal, single flat valve engine with a 100-kw. direct-current generator on the shaft.

No. 2, 16 by 15-in. at 240 r. p. m., vertical, single flat valve engine with 2 50-kw. direct-current generators on the shaft.

No. 3, 14 by 12-in., at 300 r. p. m., horizontal, single flat valve engine with 2 40-kw. direct-current generators on the shaft.

No. 4, 16 by 14-in., at 270 r. p. m., horizontal engine with 4 flat valves, and having a 125-kw. alternating-current generator on the shaft.

No. 5, 18 by 18-in., at 220 r. p. m., horizontal, single piston valve engine with a 150-kw. direct-current generator on the shaft.

No. 6, 15 by 16-in., at 250 r. p. m., horizontal, single piston valve engine with a 100-kw. direct-current generator on the shaft.

No. 7, 12 by 18-in., at 190 r. p. m., horizontal engine with 2 flat inlet valves and 2 Corliss exhaust valves, and having a 75-kw. direct-current generator on the shaft.

ECONOMY TESTS OF HIGH-SPEED ENGINES

NO.	HR. RUN BEFORE TESTS WERE MADE	CYLINDER DIAM. IN.	CYLINDER STROKE IN.	REVS. PER MIN.	PISTON SPEED FT. PER MIN.	STEAM PRESS. LB.	I. H. P. OBSERVED	APPROXIMATE LOAD	WATER PER I.H.P. PER HR. OBSERVED LB.
1	15,216	15	14	242.9	566	83.0	98.60	0.5	44.7
				240.8	562	83.0	88.75	0.5	43.6
				240.3	560	81.5	106.00	0.75	42.1
2	20,000	16	15	240.8	602	75.0	153.1	FULL	37.3
				242.4	606	75.6	101.3	0.5	39.7
3	28,644	14	12	304.1	608	90.8	124.4	FULL	37.5
				300.0	600	91.1	79.13	0.5	37.3
4	719	16.09	14	268.9	627	113.3	99.36	0.5	45.7
				268.3	626	111.6	138.1	0.75	43.4
				264.0	616	113.9	184.0	FULL	42.7
5	32,000	16 1/16	18	221.7	665	115.6	273.8	1.25	29.70
				221.9	665	114	170.8	0.75	34.80
				222.8	669	111.4	122.4	0.5	39.89
6	5,600	15.5	16	244.3	650	88.7	137.6	FULL	34.1
				246.2	658	90.9	102.9	0.75	37.0
				248.8	664	92.1	69.3	0.5	42.9
				247.8	660	82.2	36.2	0.25	56.3
7	10,800	12	18	186.4	560	90.2	111.3	1.5	34.10
				188.0	564	86.3	74.2	FULL	36.80
				189.0	567	90.4	43.0	1.5	44.02

SAVING OF STEAM

Few of us realize unless we come up against the real facts, how easy it is to throw away 10 per cent of the steam used by an engine, just by a little careless planning. One of the most effective causes of waste is wet steam in the steam chest at admission. Not only is this waste of heat in the moisture which makes up the wetness, but it causes a still larger waste by the giving up of heat to the cylinder walls.

In one case it was found that an engine which used 28 lb. of steam per hour per horsepower dropped to 25 lb. when a separator of generous proportions was cut into the steam line to remove the 2 per cent of moisture. Part of this effective work was due to the "generous" feature, for a skimpy little separator cannot do the work properly.

Going one step farther, superheating the steam to ensure dryness is even more certain and has been found in many plants the real cure for much trouble—if piping, valves and engines are adapted for it.

EXPERIMENTS IN THE MATTER of coal storage show that if coal in a pile heats above 150 deg. the temperature will rise rapidly, and when 212 deg. is reached the coal must be moved or some steps taken to cool it in order to prevent fire. Temperatures as high as 480 deg. F. were observed and at this temperature if exposed to the air the coal took fire.

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THE NEW TARIFF AND THE POWER PLANT

Materials in which the power plant field is most interested are iron, copper and lumber. In the duty on all these there has been material reduction, and the result should be to liven activity in building and remodeling plants. Among the notable reductions are those noted herewith:

Iron scrap, from the old rate of $4 to the new rate of $1 per ton; bar iron reduced 50 per cent; rolled shapes reduced 40 per cent; boiler plates reduced on an average of 40 per cent; tubes and pipe, 50 per cent; furnaces, either corrugated or plain cylindrical, 20 per cent; nails and spikes, from 20 to 33 per cent. Copper has not changed in the schedule, but aluminum is reduced 8 to 12 per cent. Duty is kept on coal at 45c a ton for bituminous and 15c a ton for slack; coke and briquets carry a duty of 20 per cent ad valorem. On rough timber duty is reduced 50 per cent, and on shaped lumber 33 to 38 per cent.

It is thus seen that on nearly all materials that enter into plant equipment there is a substantial lowering of duty. Whether this will be an advantage or not, depends on the point of view. It should result in somewhat lower prices, but as the main cost of such equipment is in the labor, this effect will not be so great as might first appear and the chief advantage to the industry is likely to be from the settled confidence as to the future. This is already in evidence, and we look to see business get continually better.

The crop report is in line to assist this growth as the record-breaking yield in oats and corn and the near-record in wheat will keep the railroads busy and be money in the farmers' pockets, which will be spent for manufactures, all of which call for power to make them.

The tariff bill itself is a compromise between the policies of the "pocketbook protectionists" and those of the tariff reformers. It is not—probably no bill ever will be—entirely satisfactory to anybody, but it is so much better than seemed likely at one time to go through the "interest ridden senate" that most pople are inclined to be thankful that it is no worse. The tariff commission and the president will be able to effect many improvements as time goes on and to get a good bill out of it in the course of the present administration.

CONQUERING THE AIR

Dreams—worthless dreams; that is all the praise that humanity has given to the ideas of countless workers in the past who have sought to rival the birds. Even now the question is often asked "can it be of use except in war and possibly in emergencies?"

This is "the age of dreams come true"; if you doubt it just open your eyes to the wonders—telephone and telegraph are too familiar to be wonders, though none the less wonderful; but we have not solved all the mystery of the wireless as yet. The submarine, the automobile, great tunnels under our streets, vast

bridges over our rivers, instruments which will measure the thickness of a soap bubble's film, telescopes which photograph stars that human eye has never seen —the wildest imaginings of the dreamers of 100 yr. ago are pale and colorless beside our accomplished facts. During the last 5 yr. progress has been steady toward flying and within the last year we have had thrill after thrill as new marks were set and new victories won. Some accidents, as are bound to come in all new developments, but no backward steps.

When you look at the records altogether it is evident that flying has arrived. Professor Langley was laughed into silence after one unsuccessful trial, spite of the fact that he was working along right lines. Only a few years and now who dares laugh at even the wildest prediction of what may be done. With Zeppelin carrying a dozen passengers close to 1,000 miles in his dirigible balloon, with Bleriot leaping the Channel in a 400-lb., 25-hp. monoplane and Wright flying for over an hour carrying a passenger in his 2 plane and flying straight away and back at 42 miles an hour; with a race set (which will be flown while this is in press in which prizes are given for longest flight, greatest speed and greatest number of passengers and in which 16 monoplanes and 26 biplanes are entered; with a company in New York offering to take orders for flying machines at 40 days' delivery, the air is near to conquest.

It has all along been a problem of power, for the greatest difficulty has been to get a motor with large capacity and light weight, and the limitations in distance and speed and most of the hitches now encountered are in the motor. So long as that runs steadily the expert aviator seems to have no trouble in going where he will.

These drawbacks must be overcome before flying becomes a matter of everyday utility, but—look at the automobile. It isn't a freight carrier either of commodities or people in masses; but it can do things that the railroad train cannot do. So the flying machine will go where the auto cannot, and will certainly give a royal sport. Likely there will be as in the auto 2 types—for light passenger service and for trucking. Funny idea that—trucking through the air!

And speaking of that, now comes the suggestion that, as the airship must be the heavy weight carrier we make it float in the air as a ship does in water, not by filling it with a light gas, but by pumping the air out. Plans have been made for such a ship which would carry 200,000 lb. or 1,000 men and travel 100 miles an hour—to Europe in 1.5 days and around the earth in 10 days. The details are not made public further than that it is to be a steel cylinder, 750 ft. long by 150 ft. diameter with cone ends. This is certainly interesting—if possible.

The records so far are: Longest distance straight away on a flying machine, 40 miles, made by Henry Farman, on July 23 in France. The longest flight with passenger, something over 50 miles, by Orville Wright, on July 27, at Ft. Myer. The greatest height estimated, 1,000 ft., by H. Latham, in his attempt to cross the Channel. The greatest speed, 42.5 miles an hour, by Wright, with passenger, on July 29. Skill in handling both craft and engines will push these rapidly upward, but perfection of motor is essential to success and that is an engineering problem.

In view of the progress so far made, such figures as are available are important and interesting. So far the monoplane seems to be ahead in regard to weight lifted per square foot of wing area, while the biplane gives a greater lift per horsepower expended. The question of speed does not seem to be settled and little attention has yet been paid to getting the shape which will have least end on resistance; the problem so far has been to get something to fly and keep on flying.

The 2 machines which have attracted most attention are the monoplane of Bleriot and the biplane of Wright. Comparative details are given in the following table:

	Monoplane.	Biplane.
Total weight	718 lb.	1,200 lb.
Span of wings	25 ft. 7 in.	36 ft.
Width of wings	5.9 ft.	6 ft.
Total area of wings	150.7 sq. ft.	432 sq. ft.
Wt. per sq. ft. of wing area	4.75 lb.	2.75 lb.
Number of cylinders	3	4
Weight of machine	132 lb.	About 200 lb.
Diameter of cylinder	4 in.	
Stroke	4.72 in.	
Rated horsepower	20	30
Wt. lifted per horsepower	35.9 lb.	40 lb.
Speed in miles per hour	43.3 estimated	42.5 measured

As showing the progress within a year, it is of interest to note that the former Wright biplane, which met with an unfortunate accident in September, 1908, weighed about 850 lb., had wings 40 ft. long by 7 ft. wide, spaced 6 ft. apart and carried a 4-cylinder engine of 30 hp. weighing 170 lb.

The flying machine is in its first crude development. What the next 5 yr. or even 1 yr. may bring forth is not safe to prophesy, but the Wrights, who are noted for conservatism in speech and action predict that the developed machine will rise easily to the height of a mile and will travel 1,000 miles at a stretch.

WE ARE USED TO SURPRISING measurements but the duration of time which a flash of magnesium or an electric spark lasts is almost beyond comprehension. It is estimated that a spark lasts perhaps 1/100,000 part of a second, and this great speed has made it possible for us to measure the speed of flying projectiles. The sensitiveness of the human mechanism is shown by the fact that from the time that a sound wave strikes the ear drum, setting in motion the whole hearing mechanism, sending from there a current to the brain, which in turn must send a current out to the hand which is to produce the motion, and the hand in turn contracts, is all done in a 2/100 of a second as measured by the stop watch of the Engineer Lipp, which is arranged to measure 1/1000 of a second.

ELECTRICAL MACHINERY AND APPARATUS

TEST OF THE CLARE ACCUMULATOR

By M. C. Saeger

THIS type of storage battery is something new on the market. The main features are the impossibility of buckling, waste of the active element and the minimum weight per ampere capacity in comparison to other types of storage batteries. The last named feature is essential where batteries are used for portable work.

The displacement of the active material by the action of the current is eliminated by the novel construction of the combined separators and element retainers as shown in Fig. 5. The element retainers are made of unglazed pottery and are porous to the acid, the acid being filtered before coming into contact with the element which prevents the entrance of foreign substances to the element. The conductors for the active material are made of rolled sheet lead 3-64 in. in thickness, holes stamped in to render circulation of the acid perfect, as shown in Fig. 3. The terminal straps are led out as in Fig. 4. Expansion and contraction, of which there is little, is compensated for by the use of rubber bands and soft rubber cushions between the outside element retainers and the tank or glass jar.

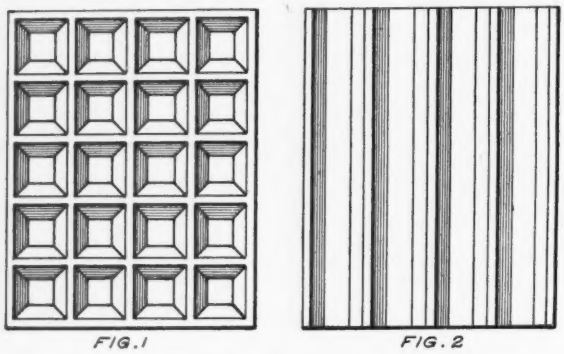


FIG. 1. ELEMENT SIDE OF RETAINER
FIG. 2. SEPARATOR SIDE OF RETAINER

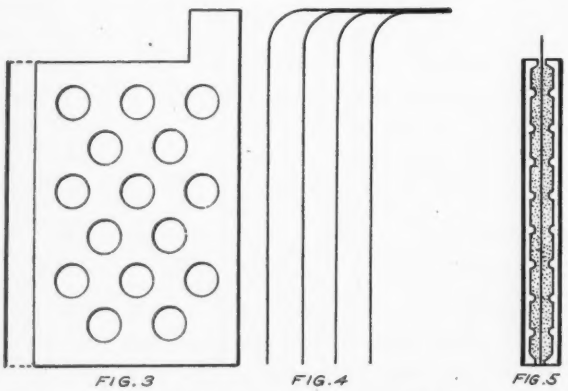


FIG. 3. SHEET LEAD CONDUCTOR
FIG. 4. METHOD OF LEADING OUT TERMINAL STRAPS
FIG. 5. CROSS-SECTION OF PLATE

The resistance of this type of cell is small in comparison to the general commercial form of accumulator.

In Fig. 6 a view is shown with a long tube projecting from the top of the battery. This tube is made of glass with a rubber washer at the end, the object in using the tube is to condense the acid vapors which form while the battery is charging. The use of this condenser tube saves the acid density from becoming lowered by the continual addition of water to replace evaporation, the tube also prevents the accumulation of acid on the cover of a portable battery jar.

An acid gas vent is necessary on all batteries, large batteries have the tops completely open, but in small portable batteries it is necessary to have a closed top that will leave out the gases, but not the acid. The cap shown in Fig. 7 fills all the requirements stated above and is used when the battery is on discharge or open circuit and removed when charging, the condenser tube then takes its place.

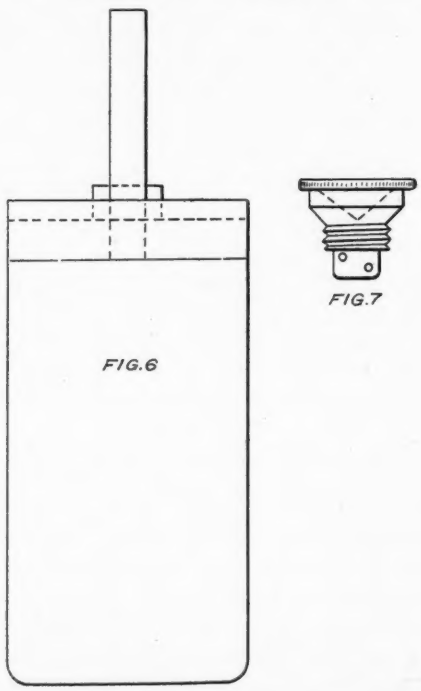


FIG. 6. BATTERY SHOWING CONDENSING TUBE
FIG. 7. ACID GAS VENT

Figures 1 and 2 show the style of construction used in the retainers; Fig. 1 is the element side and Fig. 2 the separator side.

The curve chart illustrated here shows the results of an efficiency and capacity test of a 14-ampere-hour battery, manufacturers rating. The test was conducted with a room temperature of 80 deg. F. Line B represents the chemical density of the acid exclusive of all charging and discharging current; line A represents

the first period of open circuit lasting 7 hr. The battery was then discharged to 1.16 sp. gr. at 1.25 amperes, lasting 14 hr., the e. m. f. at the end of the discharge being 1.50 volts. The charge was then started at 1.25 amperes, lasting 13 hr., the acid temperature at the end of the charge was 90 deg. F. Line D shows a period of open circuit of 21 hr., followed by a discharge to 1.15 sp. gr. in 13 hr., voltage 1.40. The battery was again charged to 1.250 sp. gr. in 12.5 hr. Discharge was started again without leaving the battery on open circuit and continued to 1.16 sp. gr. and 1.50 volts in 14 hr. Overcharge was then continued for 18 hr to 1.275 sp. gr. at a temperature of

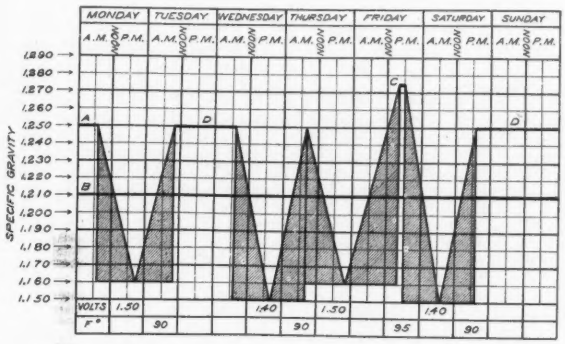


FIG. 8. RESULT OBTAINED IN A SERIES OF TESTS

95 deg. F. The battery was left on open circuit 2 hr. at C, then discharged to 1.150 sp. gr. in 13 hr., then charged back to 1.25 sp. gr. in 12 hr. These specific gravity readings do not include the temperature corrections, which are .001 specific gravity for every 3 deg. F. over 70 deg. Judging from the first few discharges, it would appear that the battery capacity had not been rated high enough, according to the high efficiency at which it operates. But that theory can be corrected by looking at the overcharge, the overcharge shows the limit to which the acid density will raise. The standard height of a regular charge is fixed at .005 to .007 below the density of the overcharge, but in this case it is working at .025 sp. gr. under the overcharge in order to keep the temperature down, thus increase the voltage and life of the battery.

TEMPORARY REPAIRING OF A MOTOR

A BURNT-OUT coil may be due either to a short circuit between adjacent commutator segments, or to the failure of the insulating covering on the wire itself, permitting convolutions next each other to make contact; in either case, a heavy current flows between the points of short circuit, rapidly heating the conductor and destroying the insulation. The invariable rule for dealing temporarily with a burnt-out coil is as follows:—Disconnect the 2 ends only of the defective coil from the commutator, and bridge over these 2 commutator segments with a piece of wire of equal section.

In bi-polar motors, whether ring or drum wound, the ends of any coil will be found in adjacent segments. The same conditions hold in multi-polar motors, if connected in multiple circuit, that is, with as many sets of brushes as there are poles. This refers to single windings only; in double, triple, etc., windings (uncommon, except in low voltage motors or generators), there would be 1, 2, etc., segments between those to which the ends of any 1 coil are connected. Single 2-circuit windings in the case of bi-polar, and multiple-circuit single windings in the case of multipolar motors of over, say 5 kw. capacity, are practically universal. Smaller multipolar sizes may, however, have a 2-circuit winding (either ring or drum), in which case the ends of the coil will be found, in a 4 pole, at practically opposite sides of the commutator, or 180 degrees apart; with 6 poles, 120 degrees apart; 8 poles, 90 degrees, and so on. It should be noted than in 2-circuit windings a "short" between adjacent segments, or between the leads from coil to commutator, will affect 2 coils at diametrically opposite points of the armature in a 4-pole, 3 coils equally spaced, in a 6-pole, etc. A coil short-circuited on itself need not, however, affect any other armature coils connected in series with it, counting from brush to brush.

It is further important to bear in mind that simply disconnecting a burnt-out coil from the commutator does not necessarily prevent the short-circuit current from flowing. Usually, the insulation is almost entirely destroyed, and the coil becomes a solid mass, absorbing power, generating heat, and affecting the insulation of adjacent coils. The only remedy is to sever each and every convolution, and fix them so that the 2 bunches of ends cannot come in contact.

A simple device, not generally known, for detecting a short circuit in an armature winding, and which applies more particularly to new machines, or when starting up after repairs, is as follows:—Energize the field magnets, and carefully and firmly hold a small piece of iron or steel, such as a screw-driver, near the pole tip of one of the magnets. If, now, the armature is started up with ample resistance in circuit, and is in good order, no variation of the pull due to the magnetism can be detected. But if a short circuit exists, a violent pulsation of the magnetism will be felt every time the defective coil passes the pole tip, owing to the heavy short-circuit current momentarily demagnetizing the field. In the case of slot-wound armatures, there is usually a slight rhythmically pulsation due to individual teeth sweeping past the pole tip; but this cannot possibly be confounded with that arising from a short circuit, the pulsation from which is strong and distinct, and once experienced, is never forgotten.

An open circuit in an armature winding is always characterized by severe sparking or flashing round the commutator, a vicious arc being apparently drawn out from the brush in the direction of rotation. The insulation between commutator segments, to which the ends of the faulty coil are attached, is gradually eaten away, so that, if permitted to continue, the commutator will be ruined. Simply bridging across the open space will, in this instance, permit the motor to go on working. It is generally advisable, however, to disconnect the ends of the faulty coil, particularly if either portion of it is earthed, as under certain conditions of supply, an earth on the motor promptly blows the fuses.

It is to be hoped that the march of progress will render failures to electrical machinery of more and more unusual occurrence. For some time to come, however, "temporary repairs" may often serve an extremely useful purpose if carried out carefully and understandingly.

BE THANKFUL EVERY MORNING when you get up that you have something to do that day which must be done whether you like or not. Being forced to work and forced to do your best will breed in you temperance, self-control, diligence, strength of will, content, and a hundred virtues which the idle never know.—*Kingsley.*

ALTERNATING VERSUS DIRECT CURRENT

COST OF WIRING, POWER TRANSMITTED

By Fred McNeill

ALL direct current generated by mechanical means is originally an alternating current and any direct-current generator may be converted into an alternating-current generator by simply replacing the commutator with suitable rings and making suitable taps therefrom to the armature; alternating current seems to be the less understood of the 2, as direct-current apparatus has been more in general use. This is explained by the fact that the alternating-current motor has only of late years reached a degree of perfection that would enable it to compete with the direct-current machine, and a prospective purchaser naturally feels a little dubious about alternating current, because he does not understand it as well as he does the old and well-tried direct current proposition.

But to decide which would be better for any given duty, is not such a hard matter as one is at first led to believe. If none of the peculiar features of alternating-current apparatus, which will be shown later, are detrimental for a given duty, the question simply resolves itself into the first cost of one as compared to that of the other, plus the operating expense.

The electrical efficiency of one system over the other has no advantage, but the commercial efficiency may differ widely, depending on circumstances.

Relative Cost

The cost of copper for a single phase, or a 2-phase, 4-wire alternating-current system, is at the least calculation 10 per cent greater than for direct current, but for 3-phase it is less.

The cost of installing wires for 2 and 3-phase is 50 per cent and 33 per cent greater than direct current. This is, of course, explained by the fact that 4 wires are required for 2-phase and 3 for 3-phase circuits.

Table I shows the relative weight of copper required and cost of installation for different systems of alternating inside wiring only.

TABLE I. COMPARATIVE COST OF INSTALLATION FOR DIFFERENT SYSTEMS; OPEN CLEAT WORK, INSIDE WIRING

System.	Actual weight of copper. Power factor. 1.00	Power factor. 0.80	Comparative cost of installation. less cost of wire.
Direct-current, 2-wire system, 110 volts	1.000	1.000	1.000
Direct current 3-wire system, 110-220 volts. Neutral wire, full size	0.375	0.375	1.500
Alternating current,single-phase 110 volts	1.000	1.200	1.000
Alternating current, 3-phase, 3-wire distribution	0.750	0.900	1.500
Alternating current, 2-phase, 4-wire distribution	1.000	1.200	2.000

Alternating-current circuits supplying current to induction motor and other inductive loads have to carry a higher amperage than that represented by the amount of power being transmitted. By inductive loads we mean loads which tend to oppose the flow of alternating current.

Angle of Lag and Power Factor

As the peculiarities of alternating current in this respect are not generally understood, a simple explanation is here given of the vagaries of the cosine of the angle of lag and power factor.

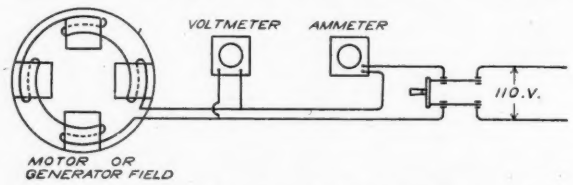


FIG. 1. CONNECTIONS FOR DEMONSTRATING A LAGGING CURRENT

For circuits carrying alternating currents having an inductance in some part of their length, such as induction motors, underloaded transformers, etc., the ordinary method of measuring the power being conveyed will not be correct, on account of the fact that the current and electromotive force (e. m. f.) do not rise and fall in perfect unison and are said to be out of phase, as they do not reach their maximum and minimum values at the same instant.

Lagging Current

When the e. m. f. reaches its maximum value before the current, the current is said to be lagging.

To illustrate the cause and effect of a lagging current, and highly inductive load, connect a voltmeter and ammeter to the field circuit of a direct-current dynamo or motor, as shown in Fig. 1, applying direct current. It will be noticed that when the switch D is closed, the voltmeter will read instantly the total pressure across the line, but the ammeter will require 2 or 3 seconds to reach the maximum, rising very slowly. The cause of this effect is the inductance of that circuit.

Current in passing around the field coils has to magnetize the iron core. The lines of force thus set up in the core, as they change, due to the increasing current, are cut by the conductors in the coils. These lines of force as they change set up a counter e. m. f. in the conductors, that is an e. m. f. that is in opposition to the e. m. f. impressed, and tends to retard any flow of current through the conductors.

When the switch is withdrawn, just the opposite effect will be noticed. A long arc will be drawn, showing that the lines of force are changing again, but they are changing from maximum to zero this time, and are therefore acting with the impressed e. m. f. and their tendency is to maintain the flow of current around the coils. Thus, it will be seen that an inductive load will retard the current when rising and try to maintain it when falling and in this manner will always prevent the current from rising and falling in unison with the voltage. Of course this is

an exaggerated form of inductive load and is only used to illustrate, but the same general effect will be there to a certain extent even in a straight wire.

Any load that will allow the current and e. m. f. to rise and fall in perfect unison, is called a noninductive load and the power flowing may be measured in the usual manner, that is, with a voltmeter and ammeter; the volts times the amperes will equal the watts. But no such ideal conditions exist in alternating-current practice. The incandescent lamp is the nearest approach to a purely noninductive load, with the possible exception of the synchronous motor, which will be explained later.

Voltage and Current Waves

To illustrate further the sine wave, Fig. 2 shows the action of an alternating e. m. f. and the resultant current of a circuit having inductance.

The curved lines represent one complete cycle or 2 alternations of alternating current, and e. m. f.; the

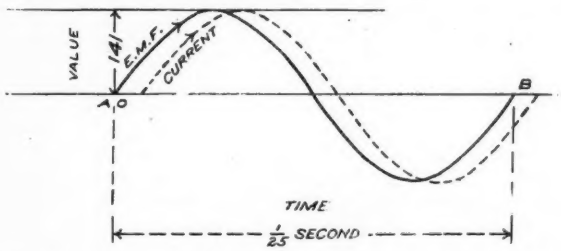


FIG. 2. LINE WAVE DIAGRAM SHOWING LAG OF CURRENT BEHIND VOLTAGE

solid curved line represents rise and fall of the e. m. f., the dotted line current; the horizontal line represents time, and vertical distances quantity.

If this curve was made from a generator, generating 100 volts and giving 3,000 alternations a minute, the time represented by the horizontal line from A to B would be 1/25 second, there being 2 alternations per cycle and 25 cycles per second. If a line be drawn parallel to A B from the top of the curve, then the value of the vertical line from 0 to 1 would be 141. In other words the maximum value of an alternating e. m. f. or an alternating current as measured at 1 volt or 1 ampere on meters is equal to 1.41 volts or amperes; and the measured values are the equivalents of direct current.

The truth of this will be obvious since the current is alternating, that is starting at zero and gradually increasing to a maximum, returning again to zero, and repeating the operation in the opposite direction.

In order that one alternating-current ampere shall have the same heating value or same effective value as one direct-current ampere, it would have to have a higher maximum, and it can be shown that the maximum value would be 1.41 or $\sqrt{2}$; or the average value of one alternating-current ampere whose maximum value is 1.41 is equal to one ampere direct current.

Power Measurement

The dotted curve, Fig. 2, represent a lagging current. It will be noted that it reaches its maximum value later than the e. m. f. and going down also reaches zero later, always lagging behind the e. m. f. Therefore, the power flowing in that current at any instant would be equal to the product of instantaneous values of the current and e. m. f. at that instant, and it can be shown that the average power flowing in any alternating-current circuit is equal to the average of these instantaneous values or to amperes on ammeter $\times$ volts on voltmeter $\times$ cosine of angle of lag = actual watts.

In practice the actual watts are measured by a wattmeter.

To find the cosine of the angle of lag, or power factor as it is called, when ammeter, voltmeter and wattmeter are available, multiply the volts as shown by the voltmeter by the amperes as shown by ammeter; the product is the apparent watts. The watts shown by the wattmeter will be found to be less than the apparent watts in any alternating-current circuit, and are called the actual watts.

$$\frac{\text{Actual watts}}{\text{Apparent watts}} = \text{Cosine of angle of lag, or}$$

power factor. In other words, the power factor is that number by which the apparent watts or volt-amperes must be multiplied to find the true watts.

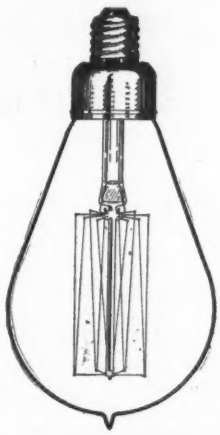
If the volt-amperes were 1,000 and the wattmeter read 900 watts, then the power factor would be $900 \div 1{,}000 = 0.90$ and would show that 10 per cent of the current flowing was without effect or wattless; therefore, to transmit a given amount of power of alternating current over a given distance at the same voltage, 10 per cent more copper would be required than for direct current, or if the power factor was unity.

Wattless Current

This difference of apparent and actual watts does not constitute a loss of power, however; the wattless current can give off no power, therefore, no power is required to generate it, but it has the same heating value as if it were in phase with its e. m. f., therefore copper has to be provided for it in the generator and motor as well as the line, and when the power factor is 0.70 or 0.75, as it is much more likely to be in practice than 0.90, the additional cost of copper in and the extra work and material required for 2 and 3-phase work, is quite liable to offset any other advantages that might be claimed for an alternating-current installation.

THE NEW 200-250 VOLT TUNGSTEN LAMPS

The advantages and economy of the tungsten incandescent over the carbon filament lamp have been practically denied to most circuits operating at 200-250



250-VOLT TUNGSTEN LAMP

volts, because the regular multiple tungsten lamps were designed for the standard voltage of 100-125. On

these higher voltage circuits, for example: 220-volts, in order to use tungsten lamps at all it was necessary to operate 2 110-volt lamps in series. Most users of the higher voltages preferred to wait for the advance of the tungsten adapted to their voltage.

In answer to this considerable demand, the General Electric Co. has extended its production of tungsten lamps into voltages from 200 to 250. This gives to the users of higher voltages the opportunity for the adoption of the economical high-efficiency lamps for multiple service. The regular G. E. 200-260 volt carbon filament lamps ranged in efficiency from 3.8 to 3.1 w. p. c. The new tungsten has the usual tungsten efficiency of 1.25 w. p. c.

They possess all the excellent qualities of the regular G. E. 100-125 volt tungsten lamps, including the same form of specially anchored filaments which made the G. E. 100-125 volt lamps so successful.

Thorough and ample tests of the new 200-250 volt tungstens show exceptionally good results, the average life and performance of these lamps being fully up to that of the standard multiple lamps. They are a decided triumph for lamp manufacture and will prove popular with all who require 200-250 volt lamps.

The lamps are supplied in the sizes from 45 to 180 watts and range in price from $1.75 to $3.95.

THE REGENERATIVE FLAME ARC LAMP

In the burning of arc lamps of the flaming arc type, there are gases and fumes evolved from the arc which, unless carried away by proper ventilation, are deposited on the globe and interfere with the light given out by the lamp. In the new lamp just brought out by the Adams-Bagnall Electric Co., of Cleveland, Ohio, these fumes and gases are utilized and the particles which might be carried away with the heated gases are circulated through the arc repeatedly and thus are used

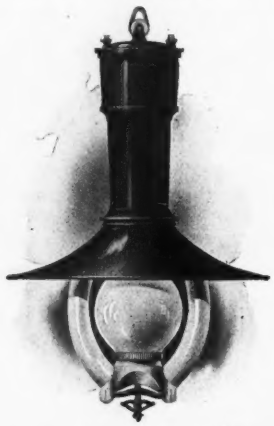


FIG. I. THE ADAMS-BAGNALL REGENERATIVE FLAME ARC LAMP

up. By this means not only is the light from the lamp greatly increased, but the life of the carbons is prolonged.

The lamp gives the characteristic orange light of the ordinary flame lamp and has the carbons placed vertically one above the other and enclosed with double globes, the inner being clear and the outer opalescent. The inner globe or top has an opening communicating with the 2 side tubes, thus allowing a free circulation of the gases in the globe, permitting them to escape from the top and return to the bottom and pass continually around through these side tubes. The side tubes are, therefore, filled with chemicals in gaseous form and incandescent so that they aid in giving out light. Both inner and outer globes are seated at the top and the bottom to prevent air from entering.

Tests have shown the life of the carbons to average 70 hr. as compared with the 14 to 16 hr. of the ordinary flaming lamp, an advantage which is obvious. The carbons are made of different material from the ordinary impregnated carbons of the flaming arc lamps; the upper one is 18 in. long and 5/8 in. in diameter, while the lower is 7 in. long by 7/8 in. diameter, consisting of a core or center of star cross section, hav-

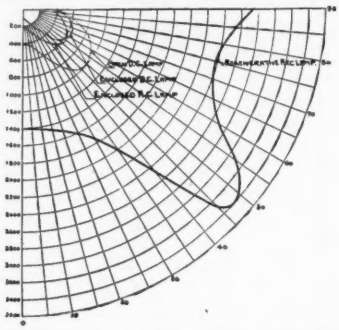


FIG. 2. DISTRIBUTION OF LIGHT FROM THE REGENERATIVE FLAME ARC LAMP

ing the radial spaces or grooves filled with a chemical composition which will give a brilliant orange ray without the presence of oxygen.

Fig. 1 shows the appearance of the lamp and Fig. 2 the curve of light distribution, from which it will be seen that the maximum light from the regenerative lamp is at an angle of about 40 deg. from the horizontal and is 3400 candlepower. The mean lower spherical candlepower is 2200, with an energy consumption of 550 watts, about the same as an ordinary enclosed lamp. This lamp runs on 110 volts in multiple with a current of 5 amperes, or runs 2 in series on 220 volts or 5 on 550 volts. It may be used for either direct or alternating current.

BIG WATER-POWER DEVELOPMENT IN NEBRASKA

Recent Omaha papers announce that plans have been completed and financed for a large water-power development using the water of the Loup River. According to the U. S. Geological Survey, this river is one of the most steady flowing streams in the country. Owing to the fact that it has a sandy bed, it has no falls or even rapids, but a continuous drop of 7 ft. to the mile, and the power has heretofore gone to waste owing to the expense necessary to make the development practical.

The project has been promoted by the Nebraska Power Co., which is capitalized at $12,000,000, and a contract has been let to the Ambursen Hydraulic Construction Co., of Boston, to put into operation a plant of 50,000 hp. at Columbus and a secondary plant of 30,000 hp. at Schuyler, which will use the tail waters from the first plant. The development when completed will transmit power to all of the principal cities in the eastern part of the state and will be a wonderful aid in developing the industrial interests in that agricultural section of the country.

MORE PRACTICAL POINTERS ON SCREW CUTTING

By L. L. Arnold

ON RECEIVING my monthly call from Practical Engineer the other day, I noted among other features, Kingsley's talk with a chief engineer upon the above subject, and as the chief, during that visit, was too busy to any more than outline the subject and as the illustrator has made that outline still more obscure by the misleading angles shown in the sketches, I will try to point out in the following description some of the details that must be closely adhered to if anything like accurate screw cutting is to be attained.

The machinists thread gage as illustrated in Fig. 1, page 346, shows the end angles entirely too blunt. These angles should be 60 deg. or just the same angle as the small cut shown on the side to which the thread tool is ground. Fig. 1, herewith, will show nearer the correct shape. The end A is used as a gage for truing up the lathe centers to the proper angle and the end B is to try the center holes in the shaft or other work which it is desired to turn or thread.

The first requisite in turning or thread cutting on centers in the lathe, is the condition of the centers. They should be true, or nearly so, to the gage, depending on the accuracy necessary in the work to be done and if not true they should be annealed and trued up to the gage before using. A portable electric grinder is handy for this work when one is to be had, as it is then unnecessary to anneal the centers before truing.

After truing they should be tested for alignment, which is done by moving the dead, or tail-stock, center up to the live center until the points are only the thickness of a piece of paper apart. When in this position it is easy to see if the points coincide, for if they do not, they should be adjusted by the screws, which will be found on the sides of the tail-stock for that purpose. If this detail is not attended to, the resulting screw will be more or less tapered, depending on the deviation from perfect alignment. If the dead center was toward the front of the lathe in relation to the live center, the resulting screw would be small on the end next the dead center. If the dead center was out of alignment toward the back of the lathe, the reverse would be the case and a nut or other part, fitted to the end of the screw, would keep getting more and more loose as it was screwed on to the work.

Having secured the correct alignment of the centers and seen that their shape was right by the gage, adjust the gears for cutting the pitch of screw desired as described by the chief to Kingsly, this description being simple and easily followed. Having gotten the lathe into the proper condition for doing the work, see that the work itself is centered properly and placed in position on the centers.

The cutting tool must next be considered and if one has any respect for its feelings, he will never attempt to cut a thread with a tool whose angle of clearance is as great as that shown in Fig. 2, page 346. The angle there shown is approximately 45 deg., while in practice 15 deg. will be found to answer all general requirements, although in some cases it would be proper to use still less.

A thread tool differs from most lathe tools from the fact that in most all other tools what is called top rake is applicable. This top rake is the grinding of a 5 to a 10 deg. angle back from the cutting edge to the body of the tool, which makes the resulting cut much cleaner and with more of a shearing action on the part of the tool. This top rake is not applicable to a thread tool unless the lathe has a compound rest, in which case, by setting the rest around 30 deg. and grinding the rake back from side C, Fig. 2, in the case of a right hand thread, this shearing action may be taken advantage of, which will give a better thread in quicker time. To use this method, the thread stop is set on the plain rest slide as would be the case in using the ordinary tool, just when the point is in contact with the work, but when the tool is drawn back on the reverse, instead of moving the nut on the thread stop to allow for the next chip, the compound rest is advanced this slight amount necessary for the next chip and the thread stop nut is not changed. This allows the side C

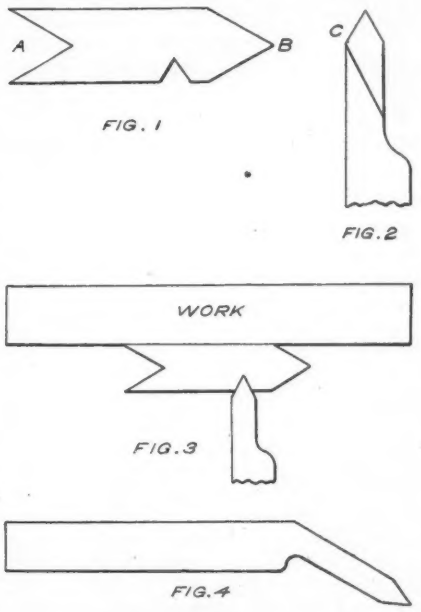


FIG. 1. MACHINIST'S THREAD GAGE
FIG. 2. TOOL SHOWING TOP RAKE
FIG. 3. USING THE GAGE TO SET THE TOOL
FIG. 4. OFF-SET TOOL

of the thread tool to do all the cutting, the angle of advance being in direct line with the angle of the thread.

This scheme will be found to be a great advantage when threading large pipes in the lathe as it obviates all the tearing effect with which every engineer is familiar who has ever had the rather doubtful pleasure of threading pipe in a plain rest lathe.

This method works equally well with work on centers. The tool should be set as near as possible to the center line of the work in any case, as if the point is too low it will bite or dig in while if set too high the heel of the tool will strike the work in spite of the clearance, so that it will not cut at all.

If it is necessary to cut the thread up to a shoulder made by a larger diameter on the work, an off-set tool like Fig. 4 will be necessary. This will allow the thread to come close to the shoulder without interfering.

If a left-hand thread is desired, all that is necessary will be to insert an idler gear in the gear train on a stud which will be found there for the purpose on some lathes, the number of teeth in this idle gear being immaterial, as its sole purpose is to reverse the direction of the lead screw in relation to the spindle. In some lathes all that will be necessary will be to shift a handle

which will effect this change without other assistance.

With the lead screw running reversed, the tool is started in at the back end of the thread and fed toward the tail-stock, or just the reverse from a right-hand thread. If it is desired to set the compound rest around for a left-hand thread it should still be set over 30 deg., as before, only in the other direction, and the top rake of the tool changed from the left-hand side to the right-hand side of the tool.

The above might be termed the A B C of screw cutting, and while not, by any means, complete, it will serve to make the other article more clearly understood. These facts are probably well known to many readers of Practical Engineer, but they may prove of some value to the men who never happened to "get up against it" along these lines.

RULES FOR STEAM HEATING SYSTEMS

By R. T. Crane

IN CALCULATING the amount of heating surface required, the proportion of heating surface to the area of the different rooms has to be determined. There is, of course, a wide variation in the proportions required for the different rooms, on account of the great difference in the exposures of the various rooms, as compared with their area.

Our general rule is that 1 sq. ft. of heating surface will warm from 60 to 100 cu. ft. of air, but people in making estimates will have to use their judgment in arriving at the correct amount.

For a corner room with much glass window surface the proportion will be 1 sq. ft. heating surface to 60 cu. ft.; with slightly less window surface 1 to 65, with moderate windows 1 to 75, for an inside room with one exposed wall 1 to 85.

Theoretically, in the upper rooms we have approximately the same amount of exposure as for the lower rooms that would require the same amount of surface for warming; but the area is considerably less, and probably the windows are shorter than the windows on the first floor, and in any case sleeping rooms do not require as high a temperature as living rooms.

The Boiler

The next thing to be determined is the size of the boiler. The rule for this is: 1 sq. ft. of grate surface will supply 133 sq. ft. of radiating surface. In a case which contains 400 sq. ft. of radiation, we divide this figure by 133, which settles the size of the boiler, which should have 3 sq. ft. of grate surface.

In settling the size of the boiler, there is a chance for some difference of opinion. My opinion is that it is just as well to have the boiler a little close in size, because if it is too large it will, of course, give too much fire in mild weather. If figured close it simply means that it will have to be run rather hard only in the few extremely cold days that we have.

Supply Pipes

There are 3 systems of piping for jobs of this kind, as follows:

The strictly 1-pipe system, in which the condensation returns to the boiler in the same pipe and against the steam.

A modification of the first system in this respect, that the main pipe falls as it goes away from the boiler, so that the condensed water follows the steam, instead of going against it, and returns to the boiler at the opposite end.

This feature applies to what might be called the main supply, but the laterals, for the sake of convenience and simplicity, are on the principle in system 1; that is, the water in that part of the apparatus returns through the same pipe and against the steam.

The third system is the regular system of separate return from each radiator to a main return pipe located below the water line.

Determining Sizes of Pipe

Our rule for determining the size of the pipe for supplying the radiators is as follows:

In the 1-pipe system, 1 sq. in. of area in the short vertical pipes running through the ceiling of the basement to the first floor will supply 50 sq. ft. of radiation.

In the vertical pipes going to the second or third floor, 1 sq. in. of area will supply 40 sq. ft. of radiation.

The horizontal pipes should be 25 per cent larger than all the other pipes combined.

The pitch of pipes should be 10 per cent.

In system No. 2, in which the condensation follows the steam, the rule is: With 5 ft. of water line, 1 sq. in. of area will supply 135 ft. of radiating surface.

In system No. 3, where we have return pipes, the same area of pipe is required as in the second system, for all main supply pipes. In cases where the lateral pipes are of some considerable length, the steamfitter must bear in mind that there is some danger of getting an accumulation of water there, which would be a nuisance, and for this reason a considerably larger pipe is used in that part of the job, so that the water which condenses in this pipe may return to the main supply.

All these rules are close to the minimum, and if the engineer who is figuring on a job has any doubt in the matter, he should always lean to the liberal side, rather than split hairs, for he will find that after mistakes have been made it is very expensive to correct them.

The above rules are intended for such temperatures as we have in Chicago.

Advantages of Each System

Systems 1 and 2 are practically the same thing, the only difference being that No. 2 can be constructed a little more cheaply than No. 1, as smaller main pipe is required.

The third differs radically from the other 2, as it permits of the regulating of the amount of steam for each radiator. This is a matter of considerable importance, or, at least, it would be so in the hands of people who would give it proper attention, for in mild weather the valves would need to be open but slightly and in cooler weather they would be open in proportion to the difference in temperature.

I think, however, that in the majority of cases very little discretion would be used in this regard, and that the valves either would be turned on full or entirely closed, so that no benefit would be derived from this feature of the apparatus.

In this construction the boiler must be so arranged that the pressure of steam cannot run above 2 lb., so that the water cannot back up into the radiators at least 5 ft.

This system could not be used advantageously in cases where there was materially less than 5 ft. of water line, as there would be too great a danger of water backing up into the radiators.—Valve World.

To polish lead pipe, scrub it with powdered pumice and a wet cloth, and after scrubbing wipe the pipe dry and polish with a dry cloth. A thin coat of white shellac or white varnish will preserve the polish.

FITTING AND ADJUSTING BRASSES

By L. R. Peiker

ONE of the most important things in the care and management of an engine is the proper fitting and taking up of wearing parts. Brass boxes should be fitted to their journals after being bored because, owing to unequal cooling of the casting, strains are released as the metal is taken out in boring, and the hole, when finished, is not a true circle. The box when taken from the chuck or face-plate, is generally too narrow across the joint face as at A in Fig. 1, the full lines of which show the brass after it is planed

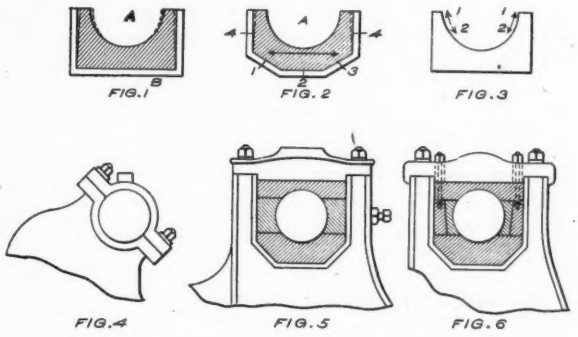


FIG. 1. BRASS BOX SHOWING DISTORTION DUE TO MACHINING
FIG. 2. EFFECTS OF BORING AN EIGHT-SIDED BOX
FIG. 3. BRASS BOX WHICH CLEARS SHAFT AT JOINT
FIG. 4. BRASS BOX PLACED AT AN ANGLE
FIG. 5. FOUR-PART BOX WITH SET-SCREW ADJUSTMENT
FIG. 6. WEDGE-ADJUSTED BOX

before boring and the dotted lines show the brass after it is bored, but somewhat exaggerated.

Scraping for Fit and Clearance

If the box was bored to nearly its finished size and released from all pressure, and then strapped on a face-plate and bored, the hole would probably be true; but this is seldom done. The most simple way to fit a box or bearing to its journal is to file or scrape the sides of the bore or bearing until the crown of the brass bears along the shaft or pin when placed upon it by hand; it should then be placed in its strap or yoke, adjusted and rotated so as to leave marks upon the surface; a thin coat of marking ink can be used. The box should then be scraped until it has a full bearing and is smooth.

Supposing the box to be well fitted to its shaft or pin, improper conditions will arise from wear, because the area of the finished part B, Fig. 1, becomes compressed, due to the pressure and jar, and stretches, causing the bore at A to close upon the shaft and bind. If the shape of the box is as shown by Fig. 2, the surfaces 1, 2 and 3 will compress and stretch, closing the diameter at A, and making the sides 4 and 4 fit loosely to their places.

There is a constant action causing the brass to bind at or near its joints, thus causing heating and excess of wear. To prevent this it is necessary to relieve that part of the bore clear of the shaft as shown in Fig. 3 from 1 to 2.

For Horizontal Thrust

In bearings receiving thrust horizontally, as in main bearings of engines, this method would not do as by it the most effective area to resist the thrust is removed, and in some the pressure on the remaining area is increased. To avoid this difficulty the joint face is sometimes placed at an angle to the line of pressure, as shown at Fig. 4. But the bearings will still close across the face of the box, it also brings the strain upon the studs or bolts more or less as the box is inclined.

The plan in general use is shown in Figs. 5 and 6, of which Fig. 6 shows the better method. It will be seen that the bearing is in 4 parts, the wear being taken up with a set screw, as seen in Fig. 5, or by wedges, as in Fig. 6, both set screws and wedges acting on cheek pieces or quarter boxes; by this means the bearing area may be extended all over the bearing. The one bad feature about Fig. 5 is that the wear is not taken up central with the bore.

When the brasses are in halves, they may be fitted so as to have a certain amount of bearing upon the shaft, and with the fit thus accurately adjusted it will wear a long time before it will require readjustment. On the other hand when the quarter boxes are used, the wear in the line of the thrust may be taken up as it wears while running.

With the engine at rest it is easy to tell by the connecting rod whether the quarter box adjustment is correct, so far as the alignment of the shaft goes; but it is not so easy to tell the pressure of the quarter box upon the journal, and when each quarter box has 2 adjusting screws it is difficult to tell when both bear alike.

The fit of the bearing can be determined only by the results; if not tight enough, the bearing pounds; if too tight, the bearing heats and wears. If the brass bore does not bear fully over its intended bearing area, the part not touching will not do its duty, and the entire wear will be put on less area than was intended in the design, causing abrasion until the bore has worn down to a bearing. The amount of wear may apparently be slight, but if some of the oil that has passed through the bearing is strained through a piece of cheese cloth the cloth will be found to contain particles of metal. Under these conditions the journal will have a dull, though smooth, appearance, but will not have a bright smooth surface such as denotes a properly fitted and easy running bearing.

In driving a key, place a rule or small straight-edge against the key and gib and with a pencil draw a line across the surface. By doing so you can tell just how far you drive the key. A method which the writer has used with success when taking up crank pin or cross-head boxes is to put the crank either at the top or bottom on a horizontal engine, and sideways on a vertical engine as that is the place of the least wear on the pins. Then move the rod backward and forward on the pin; there is usually a slight play sideways by using a small pinch bar or lever the tightness of the box may easily be seen and the brass adjusted to give the best results.

In an address before the meeting of engineers on the subject of Conservation of Natural Resources, L. B. Stillwell made the point that by electric drive of street railroads in New York in place of the steam locomotives on the elevated lines the number of tons hauled 1 mile to a pound of coal was 1.5 with steam traction and 3.85 with electric traction, so that the saving in coal in New York City by the use of central stations and electric current instead of steam locomotives is 988,000 tons of coal a year.

LETTERS FROM ENGINEERS

Send us descriptions of ways of doing new things, and new ways of doing old things. Rough pencil sketches and letters are all right; we will fix them up for the printer. All accepted contributions will be paid for when published.

A Balky Pressure Regulator

Some time since the writer had a rather interesting experience with a refractory regulator. The case was this: Two supply tanks were placed on top of the building, one at each end, and 2 pumps were installed in the engine room to keep the tanks filled with water.

The intention was to regulate the pumps by automatically controlled pressure regulators. It so happened that one of the tanks was almost directly over the pumps, which admitted of making a direct vertical connection from the bottom of the tank to the regulator, diagram of which is shown in Fig. 1. This arrangement gave entirely satisfactory results.

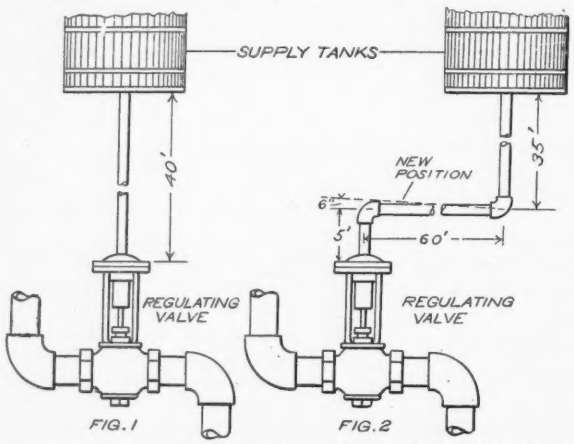


FIG. 1. SUPPLY TANK DIRECTLY OVER REGULATING VALVE
FIG. 2. PIPING WHICH GAVE TROUBLE

The other tank, however, being situated at the extreme opposite end of the building called for a horizontal run of pipe of about 60 ft. The height of both tanks was about 40 ft.

This latter arrangement did not prove satisfactory. Sometimes it would shut off the steam and stop the pump all right, and again it would not. Usually it would work until it had inspired a degree of confidence and then lie down on the job and cause a spill.

For some time it was believed to be the fault of the regulator and the regulators were changed about, which proved that the trouble was elsewhere. The horizontal stretch of pipe, which was ⅜-in., had been leveled as nearly as was possible by ordinary "try up" methods.

It was finally decided that there must be air pockets in the line sufficient to prevent the weight of the water from having a positive action upon the diaphragm at the proper time. Accordingly the line was loosened from its moorings along the joists of the basement and the end at the pump raised about 6 in. above the one at the base of the vertical section, making the line as straight as possible from one point to the other. A pet cock was then inserted in the elbow at the highest point in the pump end. The air was blown out frequently with the result that it now works as well as the other one. E. T. Binns.

Safety Valves vs. Boiler Explosions

Some months ago there was considerable discussion in this magazine concerning the proper area of safety valves. The primary use of a safety valve, is, as we all know, to prevent excessive pressure, the difficulty of proportioning the valve arises from the fact that a great many factors govern the rapidity of steam generation.

Almost any rule will do for size of valve when the water level is high, no matter what the draft or grate surface, for there is only a certain amount of fuel that can be piled into a furnace and it takes a large amount of heat to raise the mass of water in a boiler only a few degrees. So that even though the safety valve did not discharge the whole amount of steam generated, the fire would burn out before the pressure became dangerous. It would take about 110 lb. of coal to raise the temperature of the water in a 66 by 14 in. boiler from 337 deg. F. temperature of saturated steam at 100 lb. to 387 deg. F. temperature at 200 lb. (387—337 deg. = 50, 50 × 17,000 lb. water = 850,000 B. t. u. required, 850,000 ÷ 8000 B. t. u. per lb. coal = 106 lb coal). In addition, if the water level was kept up, all the entering feed water to supply that washed by the valve would have to be raised to the point of vaporization.

If the water level was not kept up and all steam outlets were closed except the safety valve, which was not quite large enough to take care of generated steam, the pressure would no doubt raise considerably, because of the reduced mass of water to be heated up. But in a boiler constructed with the standard factor of safety I think it would hardly come to the danger point. It should be noted that part of the heating surface, i. e., the top row of tubes, is useless in case of low water.

Some engineers say that if your safety valve sticks and the water is low it is dangerous to lift it because the reduction in pressure will cause steam to be generated, due to the difference in temperature between the steam and water and cause an explosion, but this is evidently false, for as steam is evaporated the pressure will rise and things be in the same condition as before, except for the loss of a little water. Valves should be so constructed, however, that even if they do stick, they will go to pieces long before the danger point.

Suppose cold water is thrown into a boiler almost the heat of the fire (the most common cause of explosion), will a safety valve of any size release steam as fast as generated? The only way to perfect safety is to make the boiler strong enough to resist the pressure of saturated steam at a temperature equal to the highest the metal may reach. C. L. F.

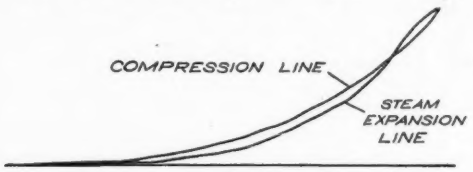
To Compress or Not to Compress

In the June number of Practical Engineer, Mr. Westerfield gives some reasons why an engine pounds from compression. Now there is no need of an engine pounding from this cause, if he refers to high-speed engines with shaft governors. He says that on heavy

loads the engine runs smoothly which is characteristic of shaft governor action which at light loads shortens its valve travel and piles up the compression until at times it is greater than the boiler pressure, and lifts the valve from its seat. When the valve returns to its seat we get the thump.

He says that on a light load the compression line is almost always above the expansion line, as illustrated, which I cannot understand. It seems to me that where the mean retarding force from compression is greater than the mean propelling force, the engine would soon come to a standstill because a bill for $1.10 cannot be paid with $1. I have never been able to carry a load on my engine which required 15 lb. m. e. p. and at the same time carry 16 lb. back pressure to heat with.

Mr. Westerfield also advises taking off exhaust lap to get less compression and earlier release, but I do not see the advisability of letting good, nice available pressure out of the cylinder until the end of the stroke; also I would rather be the fireman before the compression was lowered than after on those types of engines which have as high as 12 per cent clearance.



CONDITION OF HIGH COMPRESSION SHOWN BY DIAGRAM

It takes a good many cubic in. to fill this space. If you don't think so just figure the difference between the real cutoff and the apparent cutoff; it will astound you.

I have spent no little time in experimenting with this compression business, with the result that I want my clearance filled with exhaust rather than live steam, unless we are running a saw mill in the country where the more saw dust you can burn the less will have to be dumped into the brook.

So my solution for this pound is to lower the boiler pressure, which will lengthen the cutoff and at the same time decrease the compression, and you will have normal conditions. I have done this many times with great success. Or else the engine may be run throttled, which will do the same thing. S. B.

Water Columns

The question is often asked where the water line should be in a return tubular boiler. In my opinion this is a question that is of much importance to the engineer and fireman in charge of the above class of boiler and it should be considered much more than it is at the present time, for it is a question much neglected.

In considering the water line in a 72 in. by 18 ft. return tubular boiler, one should carry at least 5 in. of water over the top row of tubes. In carrying this amount of water it gives us 1.5 gages, plenty to carry us through small troubles that we may have with the pumps.

Then again, too much water is bad, for it makes the boiler steam harder, and when we carry water too high, more or less comes over with the steam into the cylinders, and if the boilers are the least bit dirty, it is liable to give us more trouble. There is another thing that should not be lost sight of and this is the water column connections; all pipes should be clear of scale and the bottom of the gage glass should be at least 1.5 in. above the top row of tubes.

I have noticed among engineers and firemen that when the water drops to the bottom of the gage glass, they began to pull fires, if they cannot get the pump to work. By having the bottom of the gage glass placed as above, one is not liable to burn the tubes.

In blowing down the water column, one should take notice as to how fast the water returns to its level and the fireman should blow the glass down just the same as he blows the column down. There is always a little pet cock below the gage glass and by blowing it down one keeps the glass connections open. I have always made it a practice to blow my boilers down 3 times a day, morning, noon and night, and the water columns I blow down at 6 a. m., 9 a. m., 12 m., 3 p. m. and 6 p. m., so you can see that I always have clear pipe connections, but when blowing down the water columns one should blow only for a second. There is another thing that the engineer should guard against and this is letting the blowoff valves of the water columns leak. I use an asbestos packed cock, and since using these valves I have never had a leak; they make a fine boiler blowoff valve.

Will some of the readers give their opinion on the water line as well as the kind of valves they have used?

Cal.

Pounds in Engines

In reading over Practical Engineer and almost any paper pertaining to the power plant, I find in all of them, from time to time, some engineer describes a pound in his engine that is causing him considerable worry. But a pound in an engine is hard to locate and be exact.

Sometimes men young at the business make lots of trouble for themselves trying to get rid of a pound and I will cite a case where a young fellow burned the babbitt out of the connecting rod brasses and also heated the main bearings by taking up on them until they got hot and then could not get the pound out of the engine. It was only after the company had gone to a good deal of expense that the pound was located.

The young man was a hard worker and was just what they wanted and they thought he was all right and I will say he is all right now because he has had considerable experience. The pound was caused by the babbitt on the cross head shoe becoming loose and at each end of the stroke there was a thump. The babbitt became loose because the man who did the job did not take the time to do it right or because he might be a novice at the business or because it was a poor grade of babbitt. It caused the firm and also the young engineer a lot of trouble and when the shoes were babbitted properly and the things put together again the engine ran as nice as a new, well-oiled watch.

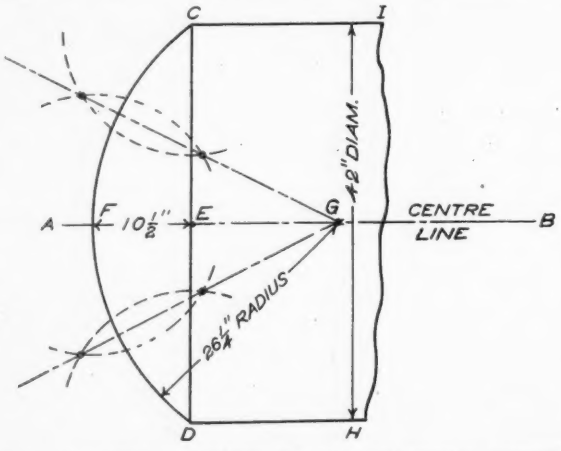
On another occasion when I accepted a position in a small electric plant in which there were 4 engines, 2 of which were run continuously, the engines ran non-condensing and the firm had a contract to heat some large buildings, that were close by, with the exhaust steam and when the exhaust was not needed they ran condensing. There was a night man and a day man and when I started everything was in good shape, but when I came on the third day there was another engine started and one of the others shut down and there was a pound in the crank end of the cylinder that was disagreeable to the ear and after listening for a minute, I asked the other man, who was going off duty, how long it had been running that way, and he told me it

did not amount to anything as he was used to it for a number of years.

After it ran for a day or more and I was getting more familiar with the place I told the man who ran opposite me that I was going to overhaul the pounding engine and he said he had fussed with it for 2 years and could not cure it and if I could to go ahead. He shut it down that night about 6 hr. before I came on and it was fairly well cooled off; so I took out the crank and steam valve and stem and made an examination of them. I found the slot in the end of the valve was a great deal wider than the T-head on the valve stem, and after satisfying myself that the slot was square with the center, I took 2 pieces of sheet iron and had them put on each side of the T head and 2 pieces of wire 0.25 in. through the T head and peened over, making them fast. I then put it in the planer, because it was too much to enter, and took a small chip off each side, and when I measured up I found that the center was true and the T head on the valve stem had play enough for the expansion. I put them back together and had it going when the other man came on duty, and there was no pound, no more than any of the others. M. J. C.

Radius of Bumped Head

Sometimes examining engineers ask this question: "How is the radius found, from which a bumped boiler head has been formed?" There are 2 methods which may be used to answer the question, a graphical or diagrammatic method and an arithmetical method. The graphical method is illustrated in the accompanying sketch, and requires but little explanation. A



FINDING RADIUS OF BUMPED HEAD BY GRAPHICAL METHOD

glance at the figure will suffice for many; but for those who may not see through it at once the following brief explanation is offered.

Suppose the diameter of a boiler drum is 42 in. and the height or use of the bump in the head is 10.5 in., and it is required to find the radius in inches to which the head has been bumped.

The center line, A B, is first drawn; the line C D is next drawn at right angles to A B, making C D 42 in. to scale. The point is measured off to scale 10.5 in. from E on the centre line A B. This gives 3 points through which the arc will pass, and from which the center of the circle of which the arc is a part, may be found. From the points C F D strike the dotted arcs as shown, and at the points of intersection draw straight lines which will in turn intersect at some point on the center line, as at G, which is found to be the center from which the arc C F D was struck. Measuring (to scale) this radius, it is found to be 26.65 in. The sides C I and D H are merely drawn in to bring out the intent of the sketch in its relation to a boiler drum. A few minutes' study of the sketch in conjunction with the explanation of the construction of the figure will make clear the whole thing.

An arithmetical statement of the problem may be made like this:

D E squared plus E F squared, divided by E F is equal to the diameter. Substituting the values given we have:

$$\frac{21^2 + 10.5^2}{10.5} = 52.5 = \text{diameter of bumped head circle}$$

or the radius equals 26.25 in.

Or it may be stated like this:

$$\frac{21^2 + 10.5}{10.5} = 52.5 = \text{diameter and}$$

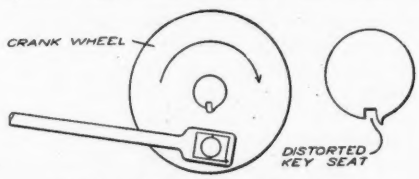
$$\frac{52.5}{2} = 26.2 \text{ in.} = \text{radius of bumped head, which agrees}$$

with the graphical method just referred ot.

The foregoing question is sometimes given to candidates at examinations, and what has been given here may be of assistance to those who do not happen to know how to proceed. Charles J. Mason.

Engine Wrecked

One morning at about 5 o'clock the engineer noticed a slight unusual noise in a 28 by 48 in. Corliss engine, and began to shut it down, but he had not given the throttle wheel more than a few turns before the false head flew off, also a section of the cylinder head. The piston was of the type usually used in Corliss engines, a bull ring follower plate, etc. The follower



DAMAGED KEY AND KEY SEAT

plate being held in place by 8 capscrews was completely demolished. The 5-in. piston rod was bent, the connecting rod was bent or cracked and the crank wheel was broken into many pieces.

Small pieces of the head and piston were thrown backwards in line with the engine with such force that they made holes in the brick walls of the engine room about 75 ft. from the engine. The engine was so badly damaged that a new cylinder and also a new crank wheel had to be made.

Scraps from the piston went down the exhaust valves, which would not let the valves rotate, and caused a twisting of the valve stems, and a breaking of the crank on the exhaust valve stem at the head end.

The cause of the wreck is supposed to have been that 1 or more of the cap bolts that holds on the follower plate in the piston broke off and came between piston and cylinder head, and as the engine came back on the stroke toward the head end the clearance was not large enough to hold the bolt without the piston

driving it through the cylinder head. This helped to smash the piston more and so many pieces of the piston were torn loose by the first jar, that the second and third jolts were so great that the piston rod and connecting rod acted as a sudden stop for the crank, which was keyed to the shaft. The momentum of the flywheel and mills in the raw end of the plant was such that it broke the crank wheel, cracked the connecting rod and bent the piston rod.

The key was also mashed backward, for as the sudden jar stopped the crank wheel, the flywheel and shaft continued to rotate and it appears the shaft turned in the crank wheel and began to shear the key before the wheel broke. The engine had been running nicely for quite a while prior to this accident. Nobody was injured in the wreck, though both the engineer and oiler had narrow escapes.

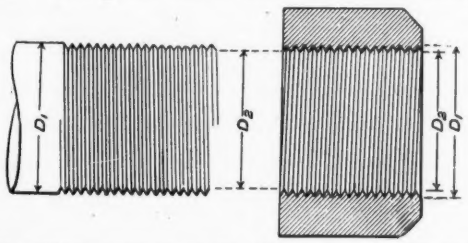
Now what caused the wreck? O. L. Harper.

Placing Screw Gear

I will give A Chief Engineer a positive rule for placing his screw gear. He says, on page 346 of the June number, "and then consider whether the lead screw or lathe spindle must revolve the faster."

He should cross his products and put the one resulting from the screw to be cut, $3 \times 16 = 48$, on the lead screw of the lathe, and the one resulting from the product of the lead screw, $3 \times 8 = 24$, on the spindle. As the screw to be cut becomes a continuation of the spindle, crossing the products determines the location of the wheels without any further consideration.

The table herewith shows at a glance the difference in size of any bolt and nut based on the depth of the thread (number of threads to the inch), regardless of the diameter of either. Having a bolt of any diameter, for any given thread, subtract the difference given in the table for that thread and it will give the size to which the nut is to be punched, drilled or bored. Having the size of the nut, add the difference



SIZE DIFFERENCES OF BOLTS AND NUTS FOR V THREADS

to get the size of the bolt. This difference allows for a full thread for both bolt and nut, to the nearest 64th of an inch.

The difference given in the table is for V threads. For Standard threads but 0.75 of this difference is to be considered. Such a table will be found useful wherever bolts and nuts are made or used.

SIZE DIFFERENCES OF BOLTS AND NUTS FOR V THREADS

	I	II	III	IV
3	3 1/2 to 4.....	.288	18/64 = .281	9/16
4	3 to 3 1/4.....	.216	14/64 = .218	7/16
5	1 3/4 to 1 7/8...	.173	11/64 = .171	11/32
6	1 3/8 to 1 1/2...	.144	9/64 = .140	9/32
7	1 1/8 to 1 1/4...	.124	8/64 = .125	1/4
8	1 & pipe,2½ & up	.108	7/64 = .109	7/32
9	7/8	.096	6/64 = .093	3/10
10	3/4	.087	5/64 = .078	11/61
11	5/8	.079	5/64 = .078	5/32
11 1/2	1 to 2 pipe..	.075	5/64 = .078	5/32
12	1/2 & 9/16.....	.072	5/64 = .078	5/32
13	1/2 (Foreign)..	.066	4/64 = .062	9/64
14	7/16&½to¾pipe	.062	4/64 = .062	1/8
16	3/8	.054	4/64 = .062	7/64
18	5/16&¼to⅜pipe	.048	3/64 = .046	3/32
20	1/4	.043	3/64 = .046	5/64
27	1/8 pipe...	.032	2/64 = .031	1/16

Rule: .866 divided by pitch $\times 2 = D_1 - D_2$.

For U. S. or standard threads take ¾ ($D_1 - D_2$).

$D_1 - D_2$ for "V" thread = 1.732 divided by pitch.

$D_1 - D_2$ for U. S. standard thread = 1.299 divided by pitch. George R. Moore.

Removing Oil from Condensed Steam

In Practical Engineer for June, 1909, Mr. Waldron speaks of using an old boiler for separating oil from heating system returns intended to be used as boiler feed.

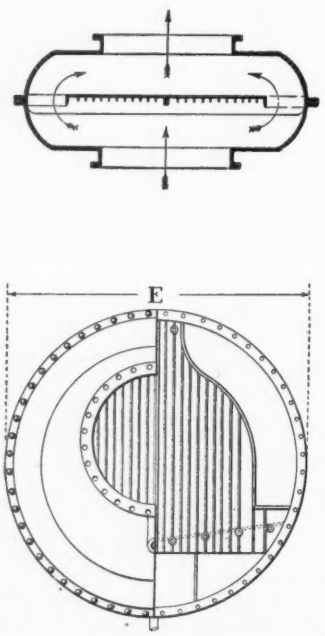
The general experience, however, has been that the removal of oil by standing is hardly satisfactory. For instance, in jet condenser plants, where the percentage of oil in the tail water from the condenser is only about 1/30 what it would be in the returns from an exhaust steam heating system not protected by an oil separator, it has been found that if a cooling pond having a capacity equal to 4 times the total amount of circulating water used per day by the condenser, be employed there is no trouble from oil, but that if the storage is less than this, oil will appear in the boilers.

The difficulty in removing oil from condensed steam is due to a fact which is often overlooked, viz., that all the oil does not exist in the water in a free state, but is present in the form of minute globules held in suspension or emulsion. These particles of oil are exceedingly small, even as small as 0.000,005 in. in diameter, and each seems to be coated with a skin of oxidized oil which prevents their coalescing. It is their exceeding minuteness which, by breaking up the rays of light, gives to the water containing them that characteristic bluish, milky appearance. Experiments show that they will remain in emulsion indefinitely; even after several months of standing such water will still have this milky appearance and no free oil will have appeared on the surface.

As found, however, in some extended investigations several years ago by the Detroit Edison Co. and also by others, these emulsified particles will break down and coalesce under high pressure and temperature, as in the boilers, and their removal, therefore, is advisable if the water is to be used as boiler feed. They cannot be skimmed from the water, and as might be expected, it is difficult to remove them by ordinary methods of filtering, or straining, since to oily particles of such very small size an ordinary filtering cloth looks about as the trees in the woods look to the birds.

If, however, the attempt to remove the oil be transferred from the condensed returns to the exhaust steam before it is condensed, the problem is much simplified. An oil separator takes advantage of the laws of momentum and of the difference in specific gravities between oil and steam. The specific gravity of oil referred to water is about 0.9; that of saturated steam at 212 deg. F., referred to water, is about 0.0006; hence a particle of oil is about 1,500 times heavier than the same volume of steam at atmospheric pressure. It is a case of a light gas carrying extremely heavy particles in suspension, and when the gas is made to change the direction of its path quickly, the particles of oil are slow to respond.

The accompanying illustration shows a separator in which the laws of momentum and inertia are taken advantage of in an effective manner. The separator is so designed that immediately upon entering it the steam is turned abruptly to either side in order to pass around the baffle; the oil and water particles shoot straight on against the baffle, down which they trickle into the oil well below, which the steam current does not enter. The oil and water cannot be scrubbed off the baffle, as the ribs prevent. I might add that these separators are guaranteed (in either the horizontal or vertical form) to deliver exhaust steam so thoroughly purified from grease or cylinder oil that this steam can safely be used for heating water by actual contact, for boiler feed, dye house and other purposes, or that this steam, when condensed, will be entirely suitable for similar uses.



SECTIONAL VIEWS OF A GUARANTEED OIL-EXHAUST STEAM SEPARATOR

For other reasons it is always better to remove oil from the steam before the steam enters the piping of a heating system or a surface condenser or closed heater in order that these appliances may remain clean and continue to operate at their maximum capacity and efficiency. Formerly it was customary to dissolve grease out of such apparatus receiving exhaust steam by means of a solution or caustic soda or lye, but now that so much mineral oil is used for cylinder lubrication this is impossible, as mineral oil is not saponified by caustics.

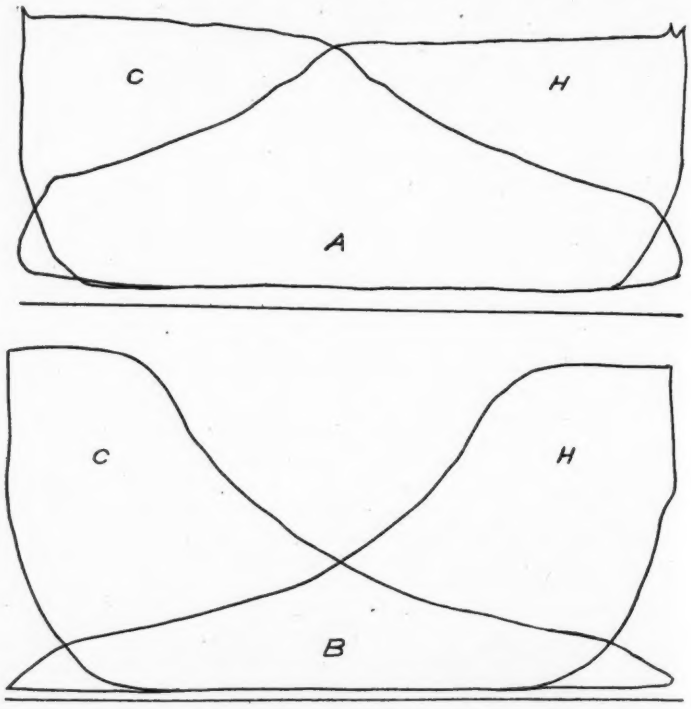
In order to be able to utilize the drips from heating systems or from closed heaters or the condensate from surface condensers, an efficient oil separator like that shown should be installed in the exhaust line from the engine. In most of the principal office buildings and hotels of our large cities having their own electric lighting plants, the boiler feed is made up of 80 per cent of such condensate, and the water circulates all winter long through the boiler, the engine, the oil separator, the heating system, the open heater and receiver and so back to the boiler, without the least trouble from oil appearing in the latter.

G. H. G.

Water Consumption Desired

I enclose 2 indicator diagrams taken from an 18 by 36 in. Fitchburg, 4-valve, automatic engine. Diagram A was taken about 2 yr. ago, using a 60-lb. spring while the engine was running at 96 r. p. m. and the boiler pressure was 110 lb.

The engine carried this same load about 3 yr., when last July the company put in another engine. Diagram B was taken in July of this year with a 50-lb. spring while the boiler pressure was 115 lb. and the engine running at 98 r. p. m.



DIAGRAMS FROM A FITCHBURG 4-VALVE AUTOMATIC ENGINE

I would like to know the opinion of some of the readers of Practical Engineer concerning the diagrams and also the water consumption of the engine. The diameter of the piston rod is 2⅞ in.

Chas. Sweeney.

Test Vacuum Gage; Stop Water Hammering; Connecting Cable to Carbon Brush; Freezing Steam Pipes.

In answer to F. W. in regard to a pump life of 28 ft., would suggest that he test the gage with mercury column.

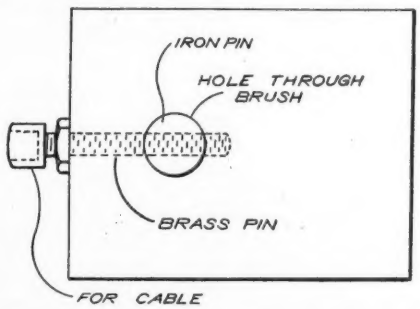
J. H. J.'s "Hammering in Water System" can probably be stopped by making sure that the pump valves are absolutely tight. I have had hammering check valves, where it looked as if the piping would be torn down, entirely stopped by grinding the pump valves. If this does not cure, reduce the lift of the discharge valves of the pump, and use an air chamber of liberal dimensions.

In answer to W. C., I would suggest to drill a hole through his brush and put in an iron pin, drill a hole through the pin as shown, and tap it; drill a hole from the end of the brush to correspond to the tapped hole in the pin, take a piece of brass rod, or iron, if he has no brass, drill a hole in one end large enough to receive the cable thread to correspond to tapped hole, put on a lock nut, screw the brass rod into the pin through the hole from the end of the brush, tighten the lock nut and solder the cable in end of the pin. This is the neatest and most effective way that I have ever seen to attach a cable to a carbon brush.

"Freezing steam pipe" under 60-lb. pressure, that's going some. Stop all circulation in the pipe, 6 to 8 ft. long, and if it is horizontal and water can be allowed to condense in it, build a box around the pipe. Make a mixture of 100 lb. broken ice, 20 lb. rock salt and 8 lb. sulphate of soda. Keep the box full of the mixture, but be sure there is no circulation by plugging the pipe beyond the valve.

With this mixture I have frozen 6 in. pipe solid in a warm engine room in 2 hr. This pipe was filled with water at 72 lb. pressure, and we safely removed a plug and put in a valve. I see no reason why steam pipe could not be frozen provided it could be allowed to fill with condensation, for I have had blow-off pipes on the mud drum of a boiler freeze with 90 lb. of steam pressure. I do not think it possible to freeze a vertical pipe or a pipe that could not be filled with water; if it is I would like to know how.

I am very much pleased with Practical Engineer, and hope that my experiences will be of some use to the boys. F. F. G.



METHOD OF ATTACHING CABLE TO CARBON BRUSHES

Proper Way to Rivet Crank Pin

A large number of crank pins that are fitted with a taper hole in the crank web and riveted to the web, work loose after a short time and cause a large amount of trouble.

The method generally employed is to cup out the end of the pin or piston rod, as the method is the same for piston rods as well as crank pins, and rivet over the edge of this cup. This is not a strong way as this thin edge will soon break off and cause the pin or rod to work loose.

A crank pin or piston rod should have a taper of about ¼ in. to the foot, this taper in itself has a tendency to hold the pin or rod more securely than the taper usually employed, which is about ¾ in. to the foot, this should appeal to the practical man for it is a known fact that the nearer straight a taper is the harder it will hold. Instead of cupping out the end of the pin or piston rod, a groove should be cut on the end about ¼ in. deep and about 7-16 in. from the edge, according to the size of the pin or rod. A ball set should now be used to rivet it up with, by spreading the metal on each side of the groove until the countersink in the web or piston is filled up. The rod or pin will never come loose as there is no thin edge to break off. The accompanying sketches will show how this is done and also the way that is now almost exclusively used and how the job will look when finished in the way described above.

H. E. Williamson.

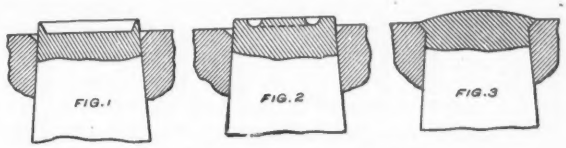


FIG. 1. METHOD USUALLY EMPLOYED
FIG. 2. PROPER METHOD TO EMPLOY
FIG. 3. FINISHED BY PROPER METHOD

Brown Engine Diagram

I am enclosing an indicator diagram taken from an old style Brown engine, 24¼ by 48-in., running at 63 r. p. m., boiler pressure 80 lb. and taken with a 40-lb. spring. I would like to hear from the readers of Practical Engineer what they think of it and how it can be improved. F. B.

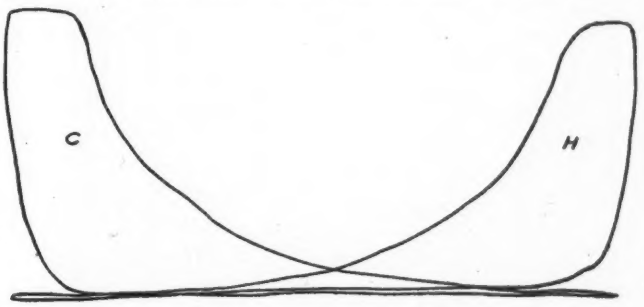


DIAGRAM FROM BROWN ENGINE

Engine Accident

On the morning of July 30, shortly after 6 o'clock, one of the large engines at the plant of the Carnahan Tin Plate and Sheet Co. was wrecked, through the breaking of the bolts of a marine type connecting rod and completely breaking away the back end of the cylinder, back of both valve chambers.

The engines were located in a pit a few feet lower than the surrounding floor, surrounded by a wooden enclosure which checked part of the flying fragments. The engineer, who was at the time standing a short distance back of the engines behind a locker, was fatally burned by the escaping steam, and died the following morning. The engine, a 36 by 72 in., was originally a Wheelock, but some time after being installed in this plant had its cylinder substituted by a Corliss cylinder and valve gear. H. A. J.

FOR GRINDING IN VALVES in combustion engines, use fine emery and oil between the valve face and seat turning the valve with a screwdriver in a bit brace or breast drill, but with only slight pressure. The job is finished when valve face and seat both show bright all over.

QUESTIONS AND ANSWERS

Our readers are invited to send in their troubles and problems; also to answer questions which are asked. All letters must have name and address of writer, which will not, however, be published. If answers are wanted by mail, send stamp for reply.

Engine Power to Drive Dynamo

I have a 12 by 24 in. engine which I wish to speed up so that it will drive a 50 kw. dynamo, and would like to know:

1. Is a 12 by 24 in. engine with a m. e. p. of 45 lb. and a piston speed of 460 ft. a minute, large enough to drive a 50 kw. dynamo?

2. If initial pressure is 100 lb. and cutoff set to give a m. e. p. of 45 lb., will the engine use steam with economy?

3. Is 2890 ft. a minute of rim speed safe with a flywheel 8 ft. in diameter, and rim 5 by 6 in?

4. I wish to put in 5 motors, a total of 65 hp. on a varying load. Would a 50 kw. dynamo be large enough?

5. I also have a 50 hp. Buckeye engine which I want to belt to a 35 kw. dynamo for lights. Could it be connected in such a way as to use either engine or both engines for power and lights? A. H. D.

A. 1. A 12 by 24 in. engine with 460 ft. a minute piston speed and m. e. p. of 45 lb. would give 142 hp. and should be able to drive a 45 kw. dynamo without trouble.

2. With initial pressure of 100 lb. to get a mean effective pressure of 45 lb. would require a mean pressure ratio of about 0.52, and with 5 per cent clearance, which is a reasonable value for a Corliss type engine, it would require cutoff of about 1-5 stroke, which would be good economy.

3. 2890 ft. a minute is a conservative speed for an 8 ft. flywheel. This should be capable of running up to 4000 ft. without any danger.

4. To take care of 5 motors, if they all have to carry full load at once for any considerable length of time it would be better to use a 75 kw. dynamo rather than a 50 kw. If, however, as is usually the case, some of the motors will be shut down or when they are running some of them will be carrying a comparatively small load, a 50 kw. machine would be large enough.

5. The only way that you could use your Buckeye and 12 by 24 engine so as to be interchangeable, would be by means of a countershaft, which would be very awkward and expensive. It would be better to connect each machine direct to its engine and then connect the dynamos in parallel, if necessary, through the switchboard.

Spacing a Circle

Q. I would like to know a rule for spacing circles. For example: suppose it is desired to lay out 8 holes in a 9 in. bolt circle on a flange. How can I figure out at what distance to set my dividers so that I can step off the holes from a given point on the circle? J. W. S.

A.—There is no universal method for finding the distance from 1 bolt hole to another for any number of bolt holes on any size circle. For 6 holes, the dividers are set equal to the radius of the circle and the holes spaced as shown in Fig. 1, for 8, the side is approximately ¾ of the radius. When it is desired to space off 12 holes on the circle the dividers are set at approximately 0.5 the radius. The exact figures for these

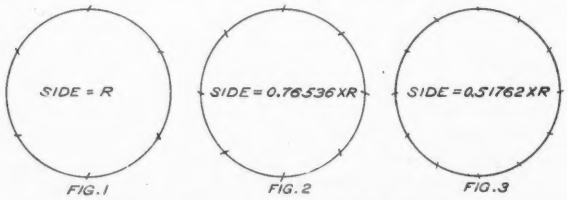


FIG. 1. SPACING FOR A 6-HOLE CIRCLE
FIG. 2. SPACING FOR AN 8-HOLE CIRCLE
FIG. 3. SPACING FOR A 12-HOLE CIRCLE

spaces are for the 8-hole circle 0.765 times the radius and for the 12-hole circle 0.517 times the radius.

Size of Air Pipe

Can you give me a formula by which the following example can be worked?

We wish to discharge 800 cu. ft. of air through a pipe 2500 ft. long with 100 lb. pressure, discharging in atmosphere, what should be the size of the pipe? T. L. W.

A. There is no direct method of figuring the diameter of pipe required to carry a given flow of air at a given pressure. The nearest data available is that to carry 600 cu. ft. per minute through a 25-in. pipe will give 14 lb. drop in pressure per 1000 ft. in length with pressure of 75 lb. Arranging a curve to take care of the values, gives that at 75 lb., to carry 800 cu. ft. a minute in a 25-in. pipe would cause a loss of 22 lb. per 1000 ft. 2500 ft. would cause 2.5 times as much loss, and the friction at 100 lb. pressure is 0.78 that of 75 lb. pressure, so that multiplying the 22 by 2.5 and by 0.78 gives us 42.8 lb. drop.

The figures on a 2-in. pipe do not run above 300 cu. ft. a minute, but taking a proportional value, a 2-in. pipe to carry 800 cu. ft. a minute would have 50 lb. per 1000 ft., and multiplying 50 by 2.5 and by 0.78 gives 97 lb. drop. From this it would seem that a 2-in. pipe would probably answer the purpose and that a 2.5-in. pipe will certainly be safe.

End Pull on an Armature

Our dynamo used for lighting runs cool and all right when the lights are off, but when the lights are turned on it runs over to the side towards the pulley, and it takes about 4 lb. pressure to force it away from the box. This makes the box heat and gives considerable trouble. Can anyone suggest the cause of the difficulty and a cure for it? C. L.

THE PENNSYLVANIA 18-HR. TRAIN, Chicago to New York, has now run for 4 yr., and for 85 per cent of the trips has been within 5 min. of schedule time.

HOW THE NEW CHIEF MADE GOOD

Getting Down to a Working Basis

By George H. Wallace

"GENTLEMEN, there's just this much about it. We have got to cut expenses some place or else go out of business. I find in looking into this thing a little that it is costing us an enormous amount to operate our factory. We've cut wages now till I dare not cut another cent. As it is, we cannot get good help. We can get just about enough men at $1.75 and $2, but they can't turn out the right quality of work—or quantity either—to enable us to meet our competitors at home and abroad.

"I have a letter from our representative in Buenos Ayres, South America, in which he says that he cannot handle our product much longer unless we improve the quality of our work and also supply an implement on which necessary repairs can easily be made. He cites here a few instances where stock repairs do not fit on the various machines for which they were made. He says also, that the English and German manufacturers can deliver machines at the wharf there cheaper than we can and that they are not only better made but wear better and are easier repaired.

"Now gentlemen, there are no 2 ways about it; we've got to make better goods, make them cheaper, make more of them, and retain our prestige not only in our foreign markets but at home as well. It is either do this or step down and out."

Thus spoke John Gautelbeim, president, general manager and chairman of the Board of Directors at the monthly meeting of that august body which looked after the business affairs of the firm of Baum & Gautelbeim, general manufacturers of machinery and supplies. It was pretty hard to name anything that they didn't make or hadn't essayed to make at one time or another with varying results.

For example, a man named Redfield came along one day outwardly attired somewhat after the fashion of the traditional spring poet, but under whose arm nestled a magnificent roll of blueprints, and in whose brain flashed the most beautiful scheme that was ever thrust upon the unsuspecting public. What the man lacked in external appearance he more than made up in what is generally known as "personal magnetism."

It wasn't exactly hypnotism, but it was so close that no Philadelphia lawyer who ever lived, could put his finger on the dividing line. His vocabulary was of such magnitude that the gaudy circus poster looked like a kindergarten chart beside it. The soft purr of his gentle voice was as oil dashed upon the bosom of the angry deep.

Mr. Redfield entered the office of Baum & Gautelbeim, told the office boy that Gauty was expecting him and rushed into the private sanctum sanctorum of the grouchy Gautelbeim. It is not necessary to prolong the agony nor to relate what transpired behind the frosted glass. It is only for us to say that in 2 hr. Redfield came out with a contract in his pocket whereby "for and in consideration of Five Thousand Dollars ($5,000) in hand paid, I, Jas. Redfield, party of the first part, do hereby transfer all right, title, claim, etc., in my Redfield Automatic Gas Engine, to the firm of Baum & Gautelbeim, party of the second part," etc., "and in return am to receive the sum of One Dollar ($1.00) per maximum brake horsepower as a royalty on all gas engines built by the said party of the second part. Said royalty to be paid upon the casting of the engine base," etc.

This is a fair sample of the numerous one-sided, flim-flam games that John Gautelbeim consummated for his firm. In the due course of time, he found himself with a yard full of engine bases of such size that it would be difficult to dispose of them. A number of engines were built and given a severe trying out on water rheostats, prony brakes, and banks of several thousand incandescent lights. They all made good—in the shop where they could be watched. But when they were delivered to the various purchasers, the only telegrams received by Baum & Gautelbeim for months were these: "Engine on the bum, send expert at once."

At the start Redfield had the experience and Baum & Gautelbeim had the money; in 2 yr. Redfield had the money and Baum & Gautelbeim had the experience. This man Redfield cost the firm over $800,000, and they had on hand about $230,000 worth of gas engine castings (on which they had paid the royalty, by the way), several tons of crank brasses, etc., which inventoried only scrap prices.

It was just such deals as this that put the firm of Baum & Gautelbeim in bad shape. True, they were

JOHN GAUTELBEIM ASSURED THE BOARD IT WAS A CASE OF FISH OR CUT BAIT

not all on such a big scale, but first and last the profit and loss account on the ledger was a much thumbed page, and one which gave the grouchy president many a heartache.

John Gautelbeim was quite a character. Tall, heavy and massive. A chest like an ox, a voice of a lion, the muscle of a grizzly bear and a cold, steel gray eye. Were he to intrude upon his majesty of Germany, he would be received as the late Prince Bismarck, risen from the dead.

This firm made, or tried to make almost everything that came along; everything from a hoe to a threshing machine. From a small beginning years ago, they had built up a large "continued-in-our next" factory which consisted mostly of a few ill-designed main buildings each, with a multitude of lean-tos and sheds attached. As the plant grew the transmission of power was the last thing thought of. Consequently, the location of the power plant was usually an after thought; located where they couldn't put anything else.

When a new addition was about ready to run, they would discover that there was no engine. The general manager was usually equal to the occasion, and always knew where he could get "just what they wanted" and

away he would go. In a few days there would be pushed into the freight yard, a miscellaneous assortment of engine, boiler, stack, pumps, etc., taken out of some old factory or sawmill, usually after a fire. These would be shoved and hauled to the desired location, hustled upon a foundation more or usually less substantial, piped up by the most direct route and "let 'er slide; will fix it up better later on when we have more time."

But the time never came to fix an engine or anything else unless it absolutely refused to turn another revolution. Let this sort of progress (?) be carried on for several years and there can be only one result—enormous waste.

Wood-working machinery was purchased by the same rule as the boilers and engines. Anything as long as it was cheap. If a double-headed sticker was a dollar cheaper than a 4-headed one, that would suit their class of work better; why, they would save the dollar—at the time. Shavings men collected by hand from beside the machines, shoved to the door overlooking the river and launched forth to the port of destruction. Edgings and scrap wood were thrown outside in a pile to be carted away by the numerous children in the neighborhood—free of charge.

Coal cost money; so did handling shavings, said Gautelbeim. He contended that it was money ahead to let them float down the river. Boiler settlings hastily erected and placed in service too soon, were cracked in numerous places. Engines creaked, groaned, slammed, banged and chugged through their daily round of duty. The combination fireman and engineer—nay, starter and stopper—perspired continuously to supply the necessary "fog." The exhaust was very pronounced and the spray that shot out of the various exhaust pipes towards the heavens above, the continuous clouds of steam, told only too clearly that there was something wrong some place—yes, several places.

There were 7 engines used for power, all different and all of the most wasteful types. Some were the old box-bed engines that our fathers ran, back in the '50's. There were cylinder boilers, 2-flue boilers, multi-flue boilers with 6-in. riveted flues, an old locomotive boiler with the Monitor inspirator still on it—and an old return tubular boiler that was swelled up in various places over the fire, like little toy balloons.

The aggregate of this promiscuous mechanical display aggregated about 2,000 hp., including a 550-volt motor, 2 125-volt motors, an induction motor, and an old rattletrap gas engine (the one for which they had paid $800,000 on the installment plan).

Space does not permit describing the factory proper, except to say that it was heated with live steam—if at all. And this was the status of affairs on the day in question when John Gautelbeim assured the honorable Board of Directors that it was now a case of "fish or cut bait."

To be continued.

RODERICK PERRY CURTIS

Roderick Perry Curtis, president of The Curtis & Curtis Co., Bridgeport, Conn., died on Monday evening, Aug. 9, at 6:10 o'clock, at Southport, Conn., the result of an automobile accident which occurred several weeks ago, in the vicinity of Westerly, R. I. Mr. Curtis did not show the effects of injuries for several days, when evidence tending to show that a blood clot on the brain existed. His condition caused alarm and he went to the Maine woods to recuperate. Last week his condition became such that he was advised to return home. Specialists were called in as his condition became more and more serious, and trepanning finally resorted to but without success.

Mr. Curtis was born in New York, the son of Lewis A. Curtis, in 1860. The family removed to Southport in 1868. He has lived in Southport ever since and was graduated from the Cheshire Academy. With Wm. D. Forbes in 1882 he founded the firm of Forbes & Curtis to manufacture the Forbes patent die stock. In 1887 Mr. Forbes' interest was taken by Lewis B. Curtis and the firm of Curtis & Curtis formed to continue the business. In 1900 the firm was incorporated under the name of The Curtis & Curtis Co., Mr. Curtis being elected president and secretary, which position he held at the time of his death.

Mr. Curtis was also secretary and treasurer of the Connecticut Golf League and an enthusiastic golfer. He was treasurer of the Pequot Library, in which he took an active interest, and a member of Trinity Church. He is survived by a widow and 3 children, the eldest, Edward Levingston Wells Curtis, who recently graduated from Yale, Lewis and Louise, both minors. He was prominent in social affairs and active in the Sons of the American Revolution, being a member of the state board of trustees. He was also a member of the New York Yacht Club, Bridgeport Yacht Club, Algonquin Club, Brooklawn Country Club, New Haven Country Club, Union League Club, Commercial Club of Charleston, S. C., Bridgeport Republican Club, B. C. M. M. R. Club of Southport, Manufacturers' Association of Bridgeport, member of Corinthian Lodge, No. 104, F. & A. M., and a 32d degree Mason. He was also director of several manufacturing corporations.

He was a brother of Lewis B. Curtis, president of the State Branch of the Sons of the American Revolution, also a resident of Southport.

NEWS NOTES

JOSEPH W. THOMPSON, inventor of the Thompson indicator and originator of the valve gear of the Buckeye automatic high speed engine, died July 15 at his home in Salem, Ohio. Mr. Thompson was born in Columbiana county, Ohio, in 1833.

AT THE RECENT ANNUAL MEETING of the stockholders of the Wheeler Condenser & Engineering Co., J. J. Brown was elected vice-president and general manager. Mr. Brown entered the condenser field some 15 yr. ago as southwestern manager for the Henry R. Worthington Co. and later became their general sales manager. After the formation of the International Steam Pump Co. he became their general western sales manager, with headquarters at Chicago, and resigned that position to take up his present work. The Wheeler Condenser & Engineering Co. has recently introduced several important improvements in condensing apparatus, among which are the dry tube surface condenser, which has shown remarkable results in high vacuum work. The company has also in hand new and improved types of rotative dry-vacuum pumps, centrifugal pumps, centrifugal jet condensers and cooling powers. The plant at Carteret is being enlarged and improved. Among these improvements is a new power house which will be equipped with several different systems of condensers for exhibition purposes, as well as for supplying the electrical energy which will be used throughout the shop.

FOR THE PURPOSE of increasing the scope and strength of the organization, the firm known as the Manufacturers' Advertising Bureau has been incorporated as the

Manufacturers' Publicity Corporation. The officers are Benjamin R. Western, president; Walter Mueller, formerly president of the Banning Co., vice-president and manager; W. H. Denning, formerly treasurer of the Banning Co., treasurer, and W. Hull Western, secretary. Messrs. Benj. R. and W. Hull Western will be remembered as the officers of the Manufacturers' Advertising Bureau. The offices of the new corporation will be at 30 Church St., New York City, N. Y.

WALTER D. RIGDON, who has been associated with the Revere Rubber Co. many years and has an extensive acquaintance, has been appointed manager of the above company's business and branches on the Pacific Coast, with offices at San Francisco, Cal., and Portland, Ore. Mr. Rigdon's headquarters will be at the San Francisco office beginning September 1st.

W. R. Pierce, formerly of the Chicago office of the same company will be assistant to Mr. Rigdon with headquarters at the Portland, Ore., office.

THE LOFTIEST CHIMNEY in the world was recently put into service at the large smelting works at Great Falls, Mont., where it will serve to carry off the gases from the greater part of the large plant. The chimney, which is built of brick, is 506 ft. in height above the ground, 50 ft. in diameter at the top, and increases gradually in diameter to the base.

THE APPOINTMENT by President Taft of Charles R. Crane to be minister of Peking, China, will meet the approval of American industrial interests, as Mr. Crane is thoroughly familiar with the needs of our industries, both at home and in the far east. Mr. Crane is a member of the Crane company of Chicago, which is one of the largest manufacturers of tubing, pipes and plumbers' supplies in this country, and has made a number of extended business trips to China and Russia, which have given him a wide acquaintance and familiarity with conditions in those countries.

THE 14TH ANNUAL OUTING and field day of the Rhode Island Association, No. 2, N. A. S. E., was held at Palace Gardens, a short distance out of Pawtucket, on July 25. Luncheon was served at 11 a. m. and dinner at 1:30 p. m. A musical and literary entertainment was provided in the pavilion by the New York bunch, under the direction of Frank Martin, of Jenkins Brothers. At the dinner Jack Armour acted as toastmaster, and there were present as speakers National Vice-President Wm. J. Reynolds, Past National Presidents T. N. Kelsey, P. H. Hogan, J. F. Carney and H. E. Stone. In the afternoon a ball game was held, which resulted in a score of 17 for the supply men and 14 for the engineers.

NEXT YEAR THERE WILL BE HELD in Berlin an American exposition for the purpose of strengthening and stimulating commercial relations between the United States and Germany. It will last through the months of April, May and June. The rental for space, including all the cost for decoration both inside and outside the building, the booths, water, heat, light and janitor service, will be $4 a square foot. The exposition palace is located in the heart of Berlin, less than 10 min. from the business section of the city.

The American committee having the matter in charge contains the names of such men as Herman Ridder, of the New York Staats Zeitung, and Francis H. Stillman, of the Watson-Stillman Co. The American office is in the Hudson Terminal Buildings, 50 Church street, New York, and the American manager is Max Vieweger.

B. F. STURTEVANT Co., of Hyde Park, Mass., has recently been reorganized and its capitalization has been increased from $500,000 to $2,500,000. It is a Massachusetts corporation, having $1,250,000 of 6 per cent cumulative preferred stock, and $1,250,000 common stock, all of which has been taken by a few of the large owners in the corporation. John Carr, Chairman of the Board of Directors of the 1st National Bank, is president of the new company and Eugene M. Foss is treasurer. E. B. Freeman has been elected general manager. This increase in capital represents capital expenditures during the last year largely in the erection of a new plant in Hyde Park which cost over $1,500,000. The company has been doing a business of about $3,000,000 a year. The enlargement of the plant has been made necessary by the increasing business of the Sturtevant company, in fans, blowers, steam turbines and engines, and the continuing growth of the business is making it necessary to still further enlarge the plant, a purpose which will be carried out next spring.

THE INTERNATIONAL ACHESON GRAPHITE Co. is enlarging the output capacity of its branch works in Niagara Falls, Ontario. This company has for many years operated a Canadian branch with facilities far in excess of the demands of the Canadian trade. It, however, recognizes in the hydro-electric development now so active throughout the Dominion and the new trade spirit and energy everywhere present throughout Canada an indication of additional industrial enterprise, and it is to meet the prospective demand for its product likely to be created by the new conditions that it is increasing the size and output capacity of its plant in Niagara Falls.

OCT. 3-9 THERE WILL BE HELD a centennial celebration in St. Louis, in celebration of the incorporation of the city. Four great pageants will be held, illustrating the city's history, its utilities, its educational strength and its industries. Balloon and airship features will be a part of the elaborate program, athletic events, fireworks and all the pageantry of a full week's celebration. Special rates on the railroads have been obtained from the principal points.

THE WESTINGHOUSE ELECTRIC & MFG. Co. has removed the sales office, formerly situated at Tucson, Ariz., to 173 San Francisco street, El Paso, Tex., where it will be continued as a branch of the Los Angeles office.

THE MANUFACTURERS' ADVERTISING BUREAU, of New York City, has changed its name to the Manufacturers' Publicity Corporation, and will as heretofore continue in the business of the preparation of advertising copy for technical advertising at 30 Church St., New York.

IN THE HUDSON-FULTON celebration, which will open on Sept. 25, will be commemorated, as well as the discovery of the river, one of the triumphs of steam and engineering—namely, the invention of the steamboat and the first voyage of the Clermont from New York to Albany. Both the little sailing vessel, the Half Moon used by Hendrick Hudson in his exploration of the river, and the first steam vessel, the Clermont, built by Robert Fulton, will be represented by exact duplicates and the Clermont duplicate will make a voyage from New York to Albany, the same as the boat for which it is named.

A tremendous assemblage of ships will be present, the U. S. Fleet, consisting of the 16 battle ships which last year went around the world, and foreign fleets to bring the total number of war vessels up to 80. It is estimated that over 800 vessels will take part in the parade, and that not a single licensed passenger steamer from New England to Norfolk remains unchartered for the opening day.

MENTAL SUNSHINE attracts the best from without and causes the best to grow within.

ENTHUSIASM

From the Dodge Idea come the following thoughts on enthusiasm which are a good tonic for torpid hustle:

Enthusiasm! Say, it's great stuff, boys.

Enthusiasm is making business the world over; dealers and salesmen are being born again.

Have you, Mr. Dealer, Mr. Agent, experienced the pleasant sensation of business heart beats, a sort of extreme palpitation of that old member hidden under your ribs when you are talking and plugging for sales? That's what the doctors are calling enthusiasm today. To the fellow who hasn't found it—God, what a pity!

You can tell a man with enthusiasm a mile off. His face fairly beams with it, and shines like a morning star. He steps like a two-year-old and his handshake has the thrill of an electric shock. His talk—who can resist it?

Enthusiasm is the mother of success. Great inventions, great works of art, great enterprises, in fact, every good thing has been accomplished through it.

Enthusiasm is a wonder-worker!

One of the best things about enthusiasm is that it is communicable. Takes quicker than measles with some folk.

The man with the proper amount finds opportunity spelled out in capital letters at every approach to business.

Enthusiasm, then, is worth cultivating at all times. We hope that our readers swallow it in overdoses and let it sink deep into their systems. Enthusiasm allows no luke-warm devotion to a cause. It compels men to accomplish the one thing they have set out to do.

Let your motto be enthusiasm. Breathe in it, eat in it, sleep in it, dream in it, walk in it and talk in it—for it means Onward, and onward means Success.

AN IMPROVED PIPE MACHINE

For any machine, the requisites are that it shall do the work well, that it shall be durable and that it shall be conveniently operated. In the Bignall & Keeler Duplex No. 8 improved pipe machine, the die-head is of the low down type which brings the handles and side levers within easy reach of the operator.

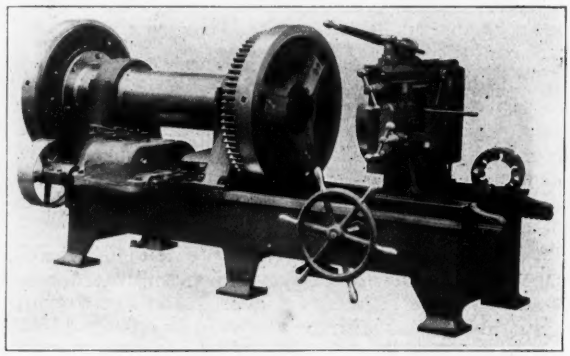
Adjustment necessary to obtain threads of different gages is made by turning the adjusting nut, which is attached to the cam-ring bracket by means of a swivel yoke. The adjusting screw passes through the nut and is connected to the side lever so that turning the nut in either direction revolves the cam ring causing the dies to expand or contract. When the die lever is down in its position for threading, it is in a straight line with the adjusting screw, which means that the dies release with the first upward movement of the die lever. This avoids any possibility of digging into the pipe.

In order to remove dies from the head, the stop latch is thrown back allowing the cam ring to revolve into such a position that the openings in the rings are opposite to the slots in the die head. This permits the removal of the dies and also allows the slot to be cleaned without removing the rings.

Steady slides which are arranged to support the pipe when being cut off have interchangeable hardened steel facings, and on one of them is attached the cutting off device which places the cutting off tool near the point of support. When it is desired to cut off pipe the steady slides are closed firmly on the pipe and the cutting off tool is brought into action. A tool post on the cutoff slide holds the reaming tool, which is always in position.

This machine will cut off and thread pipe or casing from 2.5 to 8 in. inclusive, and will stand the severest strains of making up fittings which is really harder on a machine than cutting threads. Chucks are of the independent type, each having 3 jaws with tempered steel grippers dovetailed into the ends of the slides so that they can be removed and sharpened. The slides are of steel, graduated and readily set to any particular size, those on the rear chuck having flange grippers in addition to the pipe grippers for making up flanged work.

For changing speeds, a gear-box and a compound sliding gear is arranged on one of the shafts avoiding the use of rocking gears or clutches. The gears are



BIGNALL & KEELER DUPLEX PIPE MACHINE

made of steel and run in oil and a speed plate attached to the box shows how to obtain the speed for the various sizes of pipe. By this arrangement it is possible to use a single driving pulley so that a constant belt speed is obtained. For supplying oil for the dies and cutting off tools, an oil pump is direct connected so that no oil saturated belt is needed. The shortest piece of pipe that can be threaded without a special holder in this machine is 4.5 in. between threads. The machine occupies the extremely small space of 40 by 110 in., weighs 6,900 lb. as boxed for domestic shipping and requires a 3-hp. motor to drive it. It is made by the Bignall & Keeler Mfg. Co. of Edwardsville, Ill.

ROTREX HIGH VACUUM AIR PUMP

The steadily increasing demand for high economy of steam prime movers which has been accompanying the development and application of steam turbines during the past few years, made a simultaneous advance in the design of condensing apparatus necessary.

Guided by such considerations, the C. H. Wheeler Manufacturing Co. of Philadelphia succeeded in developing a new type of rotary air pump embodying all the essential features of a high grade and high vacuum air pump, occupying but a small space with the additional advantages of being adapted for direct connection to another auxiliary. The accompanying cut, Fig. 1, illustrates one of the standard arrangements, consisting of vertical steam engine direct connected to a Rotrex air pump on one side and a centrifugal circulating pump on the other. By this arrangement, the one engine driving both pumps, the speed of the combined outfit being from 180 to 250 r.p.m. according to the size of the unit, the gain will be obvious to all engineers—eliminating as it does, the additional steam cylinders ordinarily used to drive the air pump.

The construction of the Rotrex pump, Fig. 2, is very simple, consisting of a light weight cylindrical casing, one rotor eccentrically mounted on a heavy steel shaft carried in outboard ring oiled bearings independent of the stuffing boxes. Division between the suction and discharge in the pump cylinder is made by means of a radius cam which is carried in independent bearings and is operated by means of a lever and crank from the rotor shaft on the outside of the pump.

By this arrangement internal contact, which has been the cause of the failure of practically all the rotary pumps ever devised, is entirely eliminated; the

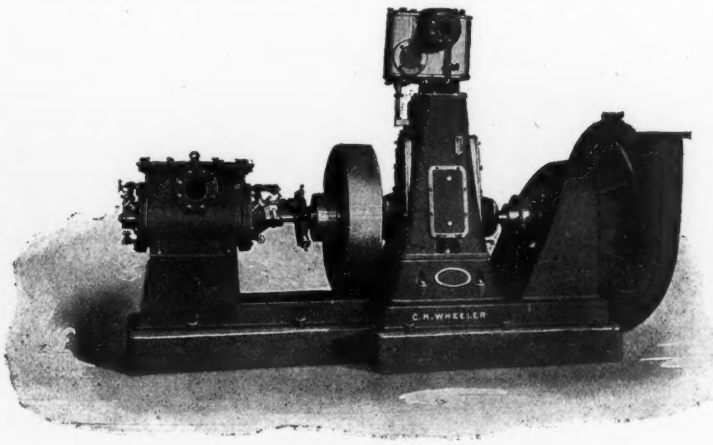


FIG. 1. ROTREX VACUUM PUMP AND CENTRIFUGAL CIRCULATING PUMP IN ONE UNIT

rotor operating with a close clearance from the bore of the pump cylinder and the cam maintaining a close clearance from the rotor. The clearances by an ingenious arrangement of ports, being thoroughly water sealed at all times, i. e., the pump relies on water sealed clearances to produce the high vacuum obtained, and not surface contact or sliding fits. The other notable feature of the pump, is a special arrangement of metallic discharge valves, no suction valves being used, thus expensive upkeep is practically eliminated.

A long series of exhaustive tests as well as per-

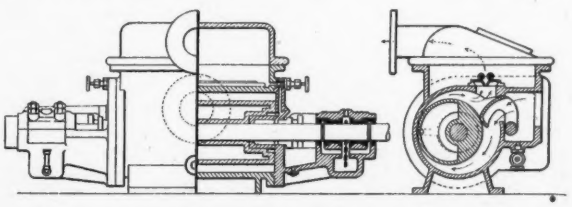


FIG. 2. SECTIONS OF ROTREX HIGH VACUUM AIR PUMP

formances of a number of pumps installed in various power plants and giving most satisfactory results, have established the Rotrex pump as being qualified in every respect to maintain the highest vacuum.

Due to the high speed, the overall dimensions are very small, which fact will be appreciated from the cut showing the proportionate size of the air pump as compared to the circulating pump and driving engine.

The pumps are being manufactured in capacities from 50 to 5000 hp. in one unit; beyond that size multiple units are used, an independent air pump engine having one Rotrex pump direct connected to each end of its crank shaft.

TRENTON ENGINE IMPROVEMENTS

In a new design of engine recently perfected by the Trenton Engine Co. of Trenton, N. J., a method of oiling has been adopted which has features of distinction and of merit. In a convenient position is placed an oil reservoir, and on the frame of the engine where it can easily be seen are arranged an oil pump, filter, oil and water separator, and the pipes for conveying the oil. The feed from the reservoir to the various

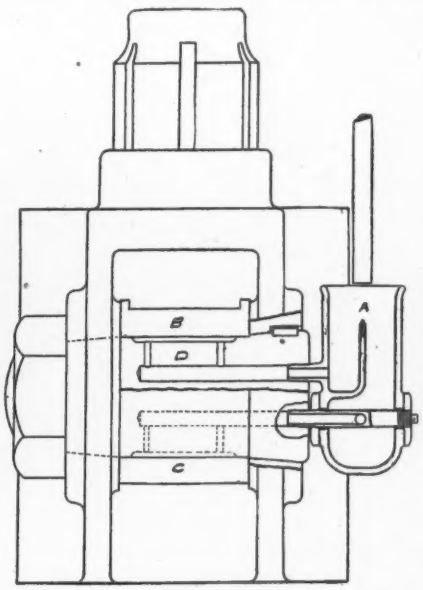


FIG. 1. OILING DEVICE FOR CROSSHEAD ON TRENTON VERTICAL ENGINE

bearings is by gravity and the oil is allowed to flow in a stream through brass tubes.

After passing through the bearings, the oil flows to the bottom of the crank pit, and thence through a filter and dust collector to the pump which is of the rotary hardened gear type and delivers the filtered oil back to the reservoir.

Motion for the pump is obtained by means of a spiral steel gear fastened to the crank shaft and driving a bronze gear on the pump shaft. The brass tubes which lead from the reservoir to the various bearings project up through the bottom of the reservoir and have near the top oblong holes running lengthwise with the tubes thus causing an equal flow of oil to each tube and preventing the taking in of sediment from the bottom of the oil reservoir. A sight glass is provided on the reservoir so that the amount of oil can be seen at all times.

By this rapid circulation of oil through the large tubes, any foreign substance is washed out instead of clogging and becoming jammed. The inside of frame and crank pit are carefully cleaned and enameled, to prevent core sand from getting into the oil, and filter and strainer prevent any dirt passing with the oil to the reservoir.

For getting oil to the crosshead pin in the vertical type of engine the arrangement used is illustrated in Fig. 1. From the pipe located above the oil cup A, oil flows filling both sides of the middle partition with oil. The upper hole connects with a cup leading to a groove in the upper part of the pin, and the bottom hole into a groove on the lower part, so that when pressure is relieved on the top or loose part of the

bearings, oil flows between the pin and the bearing at the top and the same action occurs when pressure is relieved at the bottom.

This same principle is used in oiling the crosshead on the horizontal engine which is a new type with the Trenton Engine Co., and which is shown in Fig. 2. These are single cylinder, with center crank or side crank as may be desired. The side crank unit is used to avoid the overhanging wheel, in case of belt drive, and is furnished with a piston valve which is perfectly balanced, has long travel when starting the engine, and gives good port opening at short cutoff.

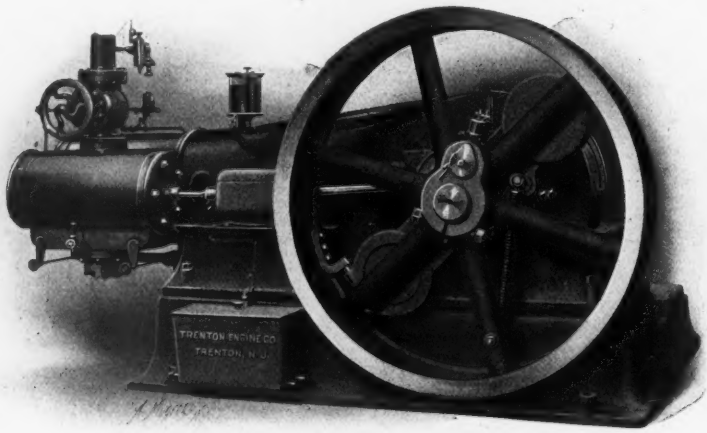


FIG. 2. TRENTON HORIZONTAL SIDE-CRANK ENGINE

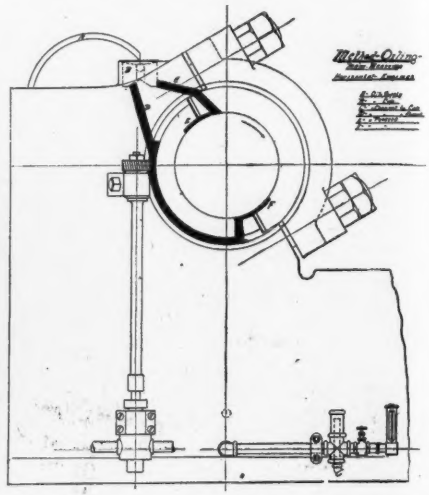


FIG. 3. OILING METHOD FOR MAIN BEARING ON HORIZONTAL ENGINE

When engines are used for direct connection or driving centrfugal pumps, a cutoff adjustment is provided so that the point of cutoff can be varied while the engine is in motion.

Oiling the main bearings on horizontal engines is accomplished as illustrated in Fig. 3. The oil comes from a reservoir through the pipe A, which comes out of the top of the engine frame and is delivered to the cup B, from which it flows to the pockets E and F through the tunnels C and D. When the shaft is pushed forward, during the outward stroke, pressure is relieved between the shaft and the frame side of the bearings, and a film of oil is carried down to the under side of the shaft, from the pocket F. When the shaft is drawn towards the frame, on the backward stroke of the piston, a film of oil is carried from the pocket E above the shaft, so that lubrication is supplied on both sides of the shaft and no point can become dry.

The crank pin is oiled by centrifugal force, through a separate pipe coming from the reservoir, and does not take waste oil coming from the main bearings. A groove cut in the counter weight which is fastened to the crank arm, so that the groove does not cut through the crank arm, serves to carry oil to the surface of the crank pin. Through a hole built for the purpose, oil flows to the crank pin surface twice in a revolution, at the time when pressure is relieved from the bearing, on the same principle as for the crosshead pin and main bearing. This double lubrication system is protected by patent and is a new device of the Trenton Engine Co. and has demonstrated its superiority for the purpose designed.

WHEN STARTING A GAS ENGINE in winter, turning the water on before starting the engine may save a broken cylinder.

A NEW PLANT FOR GANDY BELTING

With the completion of a large 4-story addition The Gandy Belting Co. of Baltimore, Md., now has one of the largest factories in the world devoted to the manufacture of cotton duck belting.

The new building has a frontage of 110 ft. on Fremont Ave. and 104 ft. on King St. It is of slow burning construction, each floor being divided into 3 bays of 25 ft. span each and one bay of 30 ft. span, their capacity being 300 lb. to the square foot, live load. The columns are of Georgia long leaf yellow pine and the floors are 4 in. thick, made of 3 in. yellow pine plank and 1 in. maple.

The careful consideration given protection from fire is evidenced in the standard tin-covered fire shutters, besides metal window frames and wire glass windows provided on all sides exposed to surrounding buildings, and in 3 fireproof stairways.

A 30,000-gal. steel water tank which surmounts this building supplies a complete sprinkler system to which an improved fire pump located in a fireproof compartment is also connected.

A large portion of the floor space is devoted to the specially constructed stretching apparatus designed by The Gandy Belting Co. When it is understood that the stretch in canvas belts has heretofore been one of the most serious drawbacks to overcome in their manufacture, the importance of the success of this exclusive device cannot be overestimated by belt users.

The business was established by Maurice Gandy in 1877.

POINTS FOR SALESMEN

Be as good as your word. Be the kind of salesman whom people will learn to trust. In no other way can you create a following which will make you valuable to your employer.

Because you are not a born hypnotist don't think that you can't learn to sell goods. It's not so hard to be tactful, courteous and accommodating.

Opportunities are going by all the time. Keep your eye out for such as you can use in your business and nab them.

Don't be lazy. There is always plenty to do if you will look for it. No one ever got rich by being lazy.

No one was ever made happy by being lazy. For your own sake, keep busy.

"It's easy enough to be cheerful when life flows along like a song," and after all it's not hard to be cheerful habitually if you take pains to get into the way of it. Get the habit.

The stronger personal hold you can get upon the customers of the firm, the more money you will be worth to your employer.

Every salesman is a link in the chain that holds business. A chain is no stronger than its weakest link.

If you discover that customers don't like to have you call on them, make up your mind that you will change that condition.

Study some branch of work on the side. Learn to make sign cards, to write advertising, to display goods, to handle correspondence. It's a busy man who hasn't time to learn something outside of his routine.

Don't talk generalities about the goods you are describing to a customer. Get right down to the definite facts and specify and make plain every small point.

Successful salesmanship is based upon an intimate knowledge of human nature. Study your customers. Get acquainted with their individual characteristics and humor their fancies.—Frank Farrington in Iron Age.

LOOK OUT FOR A RISE in the price of cylinder oil. The daily papers report that the Standard Oil Co. is about to convert its heavier oil products into "butter" to lubricate our pipes instead of our axles.

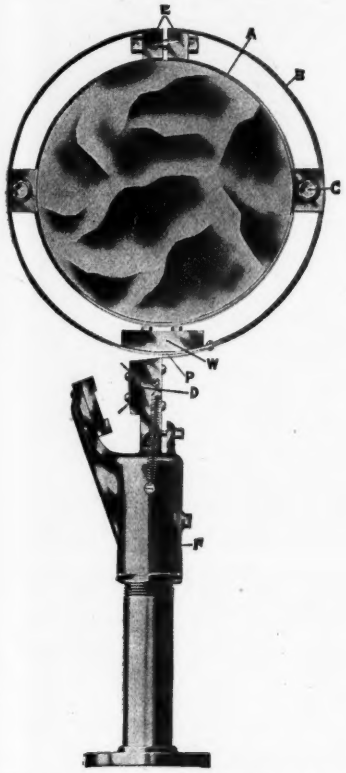
WITH A STRONG CIRCULATION striking directly against the fire sheet or hottest heating surface of a boiler the steam film is prevented, internal temperature of the sheet kept down and heat will be transmitted more freely.

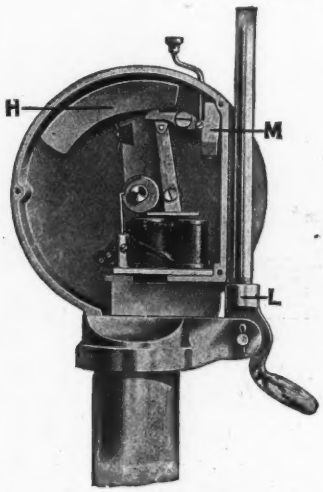
THE STRONG ENGINE STOP

Loss of life and damage to power house machinery through accidents of various kinds have led to the installation of auxiliaries and devices for eliminating accidents and insuring constant operation in nearly all power plants. The Strong engine stop, which is an automatic safety device for stopping engines in case of over speed or accidents is a new appliance to be added to the long list of safety devices.

A view of the speed limit device used in this system is shown in Fig. 1. It consists of a cold rolled steel band, A, and a spring steel band, B, fastened to the engine shaft by the clamp E, the weight W being free to move more or less from the center of the shaft as the speed of the engine varies; the side clamp, C, can be moved toward or from the weight as the speed of the engine demands. The speed limit consists further of a stand, F, at the top of which is a lever, D. With the engine running at normal speed, F can be adjusted in height until D is just out of striking distance of the hardened point, P. The slightest increase of the speed of the engine will throw the point, P, a slightly greater distance from the center, striking the lever D, bringing it in contact with the arm of the stand, F, which closes the electric circuit.

By referring to Figs. 2 and 3, which show the stop set and released, it will be seen that the instant current passes through the magnet coils, in the engine stop, the magnet bar is drawn down and with it the lever M. This releases the hammer, H, which drops and knocks the rod, L, from its support and closes the quick-closing valve, which is operated by a weight on the end of a lever, as shown in Fig. 4. The latch, O, Fig. 3, locks the hammer in place, so that the rod cannot be placed on its support until the hammer returns to its normal position. The lever D can then be returned to its vertical position.





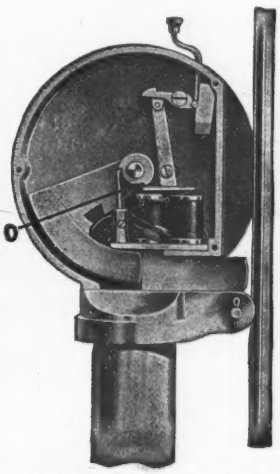


FIG. 1. SPEED LIMIT DEVICE FIG. 2. POSITION OF STOP WHILE ENGINE IS RUNNING FIG. 3. ENGINE STOP RELEASED

The current to operate this engine stop is furnished by a storage battery and the wiring may be arranged so that by pressing a button located anywhere in the plant, the engine may be stopped in case of accident. The only thing which could be neglected by the engineer and thus make the stop inoperative, is lack of attention to the storage battery. A duplicate set of batteries is furnished with each installation and also a reliable voltmeter. This meter not only checks the condition of the battery for the benefit of the engineer but shows at a glance whether the apparatus is being

taken care of properly. The stop can be tested at any time by pushing the button, an attendant standing at the stop and catching the lever as it is thrown from its position, and if the stop is reset immediately, the speed of the engine need not be affected.

This engine stop is another example of the simplicity and reliability which marks all appliances made by its manufacturers, the Strong, Carlisle & Hammond Co. of Cleveland, O.

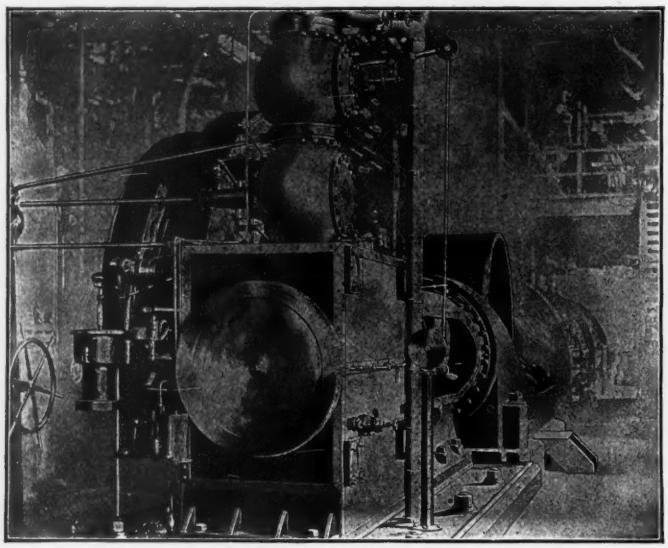


FIG. 4. STRONG STOP ATTACHED TO ENGINE

WING'S TURBINE BLOWER

Engineers who are compelled to employ forced draft in their power plants will appreciate the extreme simplicity and efficiency of Wing's turbine blower, which is a combination of a disk fan and a turbine engine. The engine consists of a series of buckets or vanes fastened to the outer end of the fan or blower blades to receive the impulse of steam and 3 or 4 nozzles from which the steam impinges on the turbine buckets that are especially designed to get the highest possible value of the expansion of steam and thus give a positive and economical power to drive the blower.

An idea of the size and operation of this blower may be gained from the illustrations Figs. 1 and 2; Fig. 1 showing the blower detached from the setting with a section of the steam chamber removed to show the location of the vanes. Figure 2 is a cross section of the blower, as installed in the boiler setting. The steam, which has been used to drive the blower, passes in under the grate with the air, thoroughly mixed, and heats the air for combustion, thus combining the advantages of both the fan and steam jet systems.

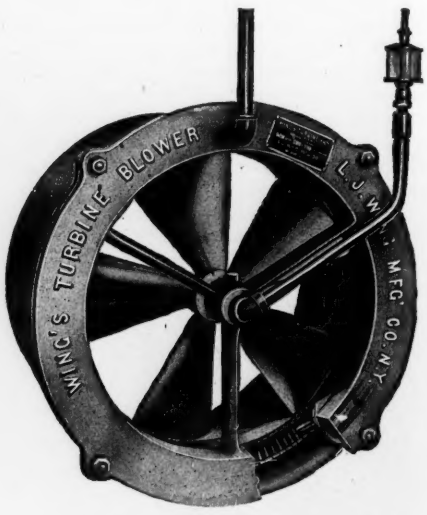


FIG. 1. WING'S TURBINE BLOWER

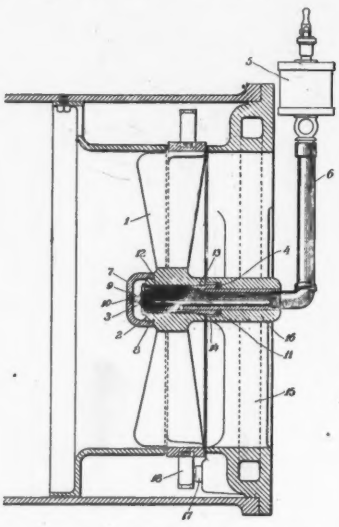


FIG. 2. SECTIONAL VIEW OF TURBINE BLOWER

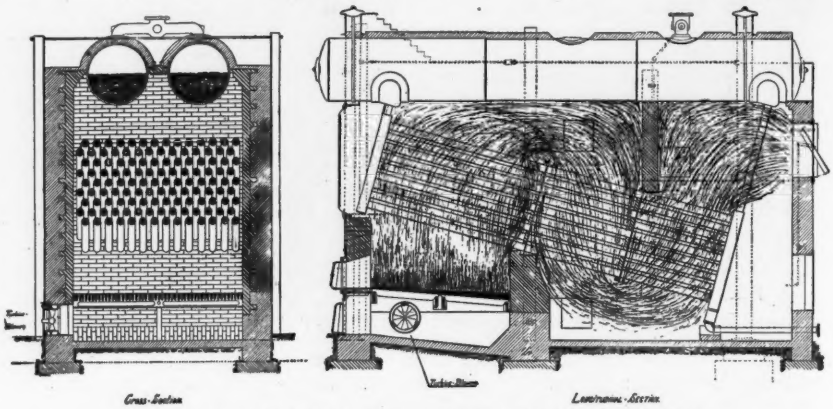


FIG. 3. TURBINE BLOWER INSTALLED IN BOILER SETTING

As usually installed, each boiler has its individual blower which is placed in the side or rear wall of the setting, as illustrated in Fig. 3. The system, when complete, is automatic in operation and requires no further attention than to see to the lubrication.

The advantages claimed for the Wing's turbine blower by the manufacturers, L. J. Wing Mfg. Co., are all those claimed for the fan and steam jet systems, such as an economy of fuel, perfect combustion, higher efficiency of boiler, economy of floor space, low chimneys, hot air draft, etc.

BELTING TROUBLES

Causes Which Lead to Belting Difficulties and Methods to Lessen Them

By G. S. Baker

WHEN direct connected motors were first perfected and placed upon the American market, certain engineers prophesied that before many years had elapsed belting for transmission purposes would be a thing of the past. Up to the present time this prophecy has not come true. While direct-connected motors have replaced thousands of feet of belting in the various factories of our country, the effect on belting itself and its volume of sale is not yet perceptible. In fact, we have the statement of one of the largest manufacturers of leather and textile belting that the demand for belting for transmission purposes is nearly 50 per cent greater in its volume than it was 5 yr. ago. This may be accounted for in a large degree by the

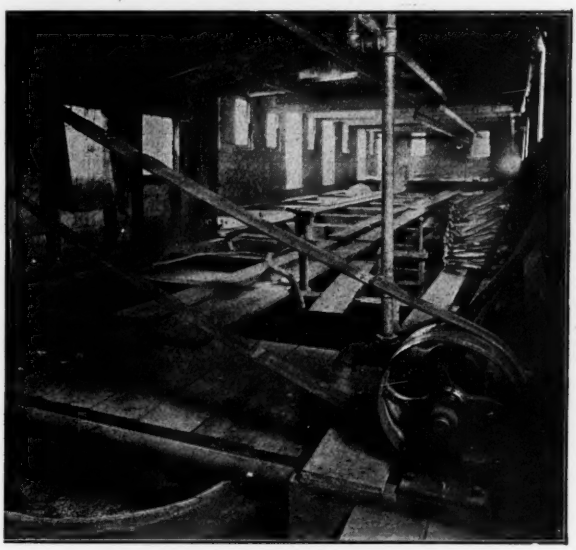


FIG. 1. A LEATHER BELT WHICH COULD NOT WITHSTAND WET USED UP AFTER 3 MO. SERVICE

vast increase in the size of manufacturing plants during the past half decade and by the fact that during that period myriads of new factories have gone up and are still going up in all parts of the country.

In the United States today the leather belting used to transmit power to the various machines in our combined factories amounts to several billion feet. The annual cost of belting for the factories of this country is a little less than fifty million dollars. Since this enormous amount of money is spent annually by our factories in belting equipment, it is an economic problem of the greatest importance to discover what proportion of this annual expenditure is wasted, either through lack of knowledge on the part of engineers as to what type of belting to recommend or owing to the fact that the best quality of goods were not bought.

An investigation was recently made to determine some of the conditions as they exist in belt transmission, in an effort to ascertain:

The principal conditions which lead engineers and factory superintendents to install improper types of belting.

And what methods of manufacturing belting should be followed to reduce the costs of replacements to a minimum.

Expert opinion on these subjects by the New York Leather Belting Co., which has recently been making a fight to raise the standards of production in its line, we believe will be valuable to engineers generally in giving them a better understanding of what values in belting actually are, how they can be distinguished and how replacement costs may be reduced. These opinions and the results of the company's experience are given below.

Lack of Knowledge About Belting

The fundamental cause of belting trouble and of high belting cost may be said to be lack of knowledge of belting on the part of those in charge of transmission in factories. This lack of knowledge consists of:

First: Ignorance on the part of those in charge of

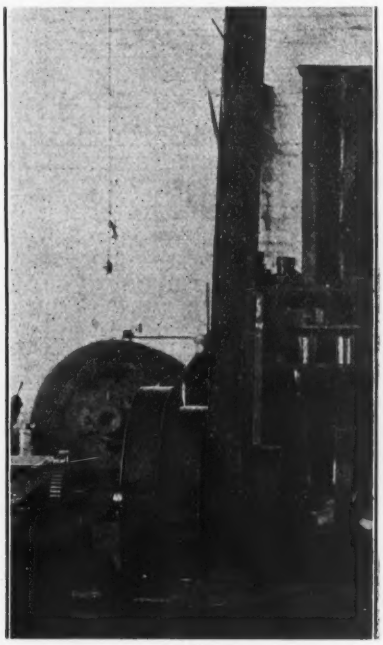


FIG. 2. A BELT SOLD CHEAP; GONE TO PIECES AFTER 3 MO.

shop equipment as to the most economical types of belting for various classes of machinery.

Second: Lack of knowledge of what constitutes best quality belting and how to discriminate between first quality belting and belting of inferior quality.

Fully 0.5 of the costly and needless replacements in belting in our largest machine shops and factories is due to the fact that belting is installed on the guesswork plan. In other words, some types of belting have been demonstrated to last longer, develop greater horsepower and show a greater degree of economic efficiency than other types of belting on particular machines.

Wrong Installation Not Excusable

The installation of the wrong type of belting by those in charge of shop equipment is not excusable. Often the man in charge of this department takes the counsel of some young and inexperienced belting salesman on this subject, but need not do this for several of the larger belt manufacturers maintain efficient engineering departments whose sole business is to give out practical and tested advice as to best types of belting for different classes of machinery.

Ability to Distinguish Quality in Belting

Few of those in charge of shop equipments are able at sight, or even upon careful investigation, to tell whether the belting which is delivered to them is of first quality or not. Belting, when it is placed upon the market, whether built along the most approved lines of quality, or in the cheapest manner possible, all looks slick and shiny, and can be loaded up by means of destructive mineral oils to attain any weight desired.

Owing to the difficulty which is generally felt in distinguishing first quality leather belting from inferior quality, various dishonest practices have been resorted to in recent years by unscrupulous manufacturers.

Cutting Quality to Shade Price

Those unscrupulous manufacturers who have recognized this condition to be prevalent take practically

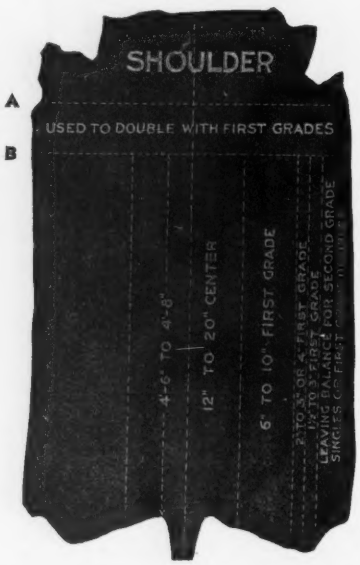


FIG. 3. COMMON METHOD OF CUTTING BELT FROM HIDE

no chances when they cut 30 or 40 per cent in the quality of their goods to make a 20 per cent reduction in price. Thus it often happens that the lowest bidder on specifications of highest quality makes more money on the deal than the highest bidder who planned to actually furnish the qualities asked for in the goods delivered.

Some manufacturers are not as openly unscrupulous as others. They take precautions. It is an old-time trick of many belt manufacturers, who believe that their goods will be inspected, to put belting which meets the specifications on the end of each roll delivered. The man who tests the belting religiously clips off a strip from the end of each roll; the tests made prove the goods admirable, and the interior of the roll is not inspected.

Another ruse in common practice is in connection with double leather belting. Specifications for the widest widths usually call for all center stock belting. Belt manufacturers often use all center stock belting for 1 of the 2 plies, using well polished shoulder and flank stock for the other ply. This kind of belting often passes muster and prices are paid for it which should ensure the delivery of both plies from center stock. The strength of a double belt of this sort is, of course, much less than if both plies were made of absolute center stock.

The Ease of Belt Deception

But the great majority of unscrupulous belt manufacturers who bid on large equipment deals, do not go to the trouble of following methods of this character. It is not necessary. The belting is sold at a low price with claims of best quality. It is delivered to the plant. Casually inspected, it looks new, strong and shiny and no questions are asked. It is put on the pulleys and no records of its service are kept; when a belt goes to pieces a new one is ordered. In this way the belt manufacturers fatten on costs of replacements at the expense of the factories which buy the belting.

We cite herewith in full this plan which if adopted as standard specifications by belt users can bring belt manufacturers generally into line for high standards of production. Tests should, of course, be carried on

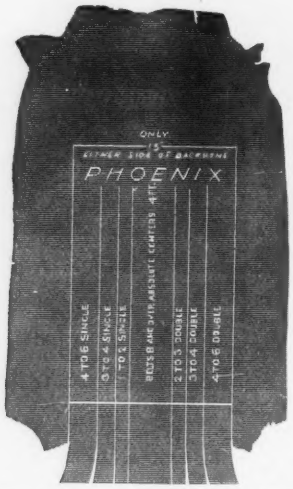


FIG. 4. PROPOSED NATIONAL SYSTEM OF CUTTING LEATHER BELTING

systematically to make sure that the specifications are lived up to.

Plan to Protect Users of Belting

All belting manufacturers who have facilities for building best quality belting should adopt a standard specification for first grade belting, viz.:

a. Belting made from oak-bark tanned butts.

b. Only center portions of hide used.

c. Strips put into belts not to exceed 4 ft. 6 in. in length.

d. Weight about 16 oz. to the square foot.

e. Every strip for each width of belt taken from definite fixed location in the hide, as shown in Fig. 4.

As physical proof to the user that these claims are fulfilled in the belting delivered, this absolute test is easy to apply and sure in its proof. Each manufacturer shall furnish to every dealer who represents him, a belting butt, having sides and centers attached, with strips to illustrate the exact nature of material which enters into every width into which the belting will be manufactured. By comparing the roll of belting with strips in the sample butt, and by comparing the pit or hair pores of the leather in the roll with that in the corresponding strip in the belt, a novice in belting may prove to himself just what he is getting. Every large user of belting should have a sample butt of this sort at his plant.

A stamp shall be adopted which will be recognized as a national quality stamp for first grade belting. All manufacturers who can prove they are capable of building belting according to standard specifications, shall be allowed to place this stamp as a guarantee on their first-grade goods. This stamp shall be the property of a national committee representing the supply dealers of the country, since they supply 50 per cent

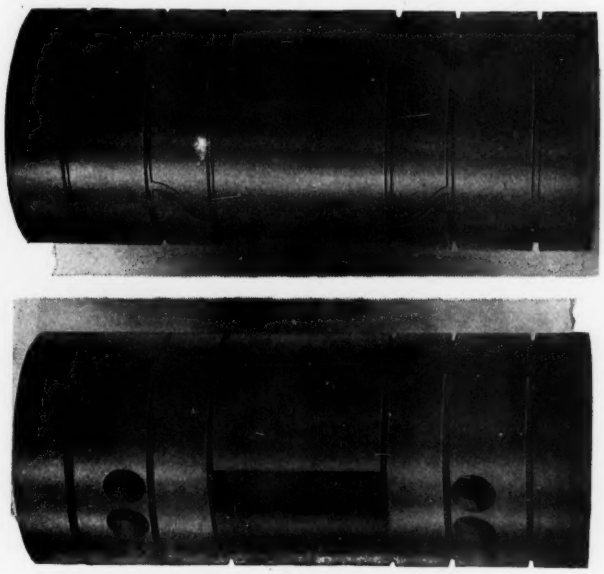


FIG. 1. TOP AND BOTTOM VIEWS OF STEAM VALVE

of the belting used by consumers, and this committee shall withdraw the use of this stamp from any manufacturer who uses it on goods which do not meet standard specifications.

The verified complaints of any belting users that goods bearing this stamp which do not fulfill the specifications, have been delivered, shall be sufficient to have the stamp withdrawn from that manufacturer.

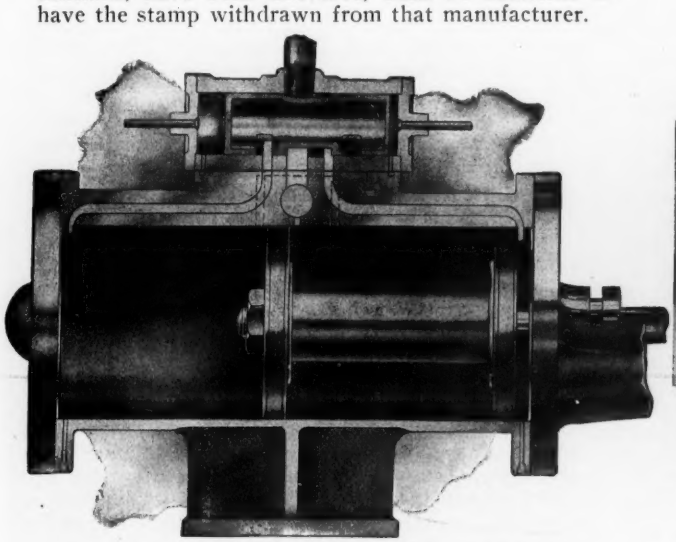


FIG. 2. CROSS-SECTION OF STEAM END OF PUMP

The adoption of this plan will eliminate the possibility of fraud in the delivery of belting, since it gives the user a double check: 1. Physical proof that he can apply for himself; 2, a guarantee in the shape of a national quality trademark.

DU BOIS SIMPLEX PUMP

Simplicity of design, one steam valve, positive operation and excellent efficiency are commendable features of the DuBois simplex pump. As shown by the illustration, Fig. 1, the steam valve is what is known as a hollow piston valve, made in one piece, and having one diameter throughout. The steam being equally distributed within the valve makes it perfectly balanced and eliminates friction.

The valve mechanism is confined to 1 piece, which reduces trouble to a minimum. The valve is positively steam-tight; the amount of wear being no greater than that on any horizontal piston, there is no danger of steam leaking past the piston.

By referring to Fig. 2 it will be seen that the steam entering the valve chest is conducted to the cylinder through the main port, forcing the piston the full length of its stroke and past a port leading to a by-pass that carries the steam to the opposite end of the valve, shunting it forward, thereby reversing the stroke.

The operation of the valve is thus fully assured, but at no time can it open or let steam into the opposite end of the cylinder until the piston has completed its full working stroke. The valve is fitted at each end with outside rods to release it should it become gummed or corroded when standing idle any length of time.

The illustration, Fig. 2, also shows the steam clearance in the valve chest and valve cylinders to be small, and no unnecessary pockets or openings for steam to gather and condense in are found in this pump; these features insure good economy.

The piston rod is the only place where stuffing boxes are used and these are readily accessible and in plain sight for attention, when necessary. The stuffing boxes are brass, fitted with screw packing nuts, which provide for taking up the packing evenly, thus giving positive alignment between rods and glands.

The water end of the pump has not been neglected,

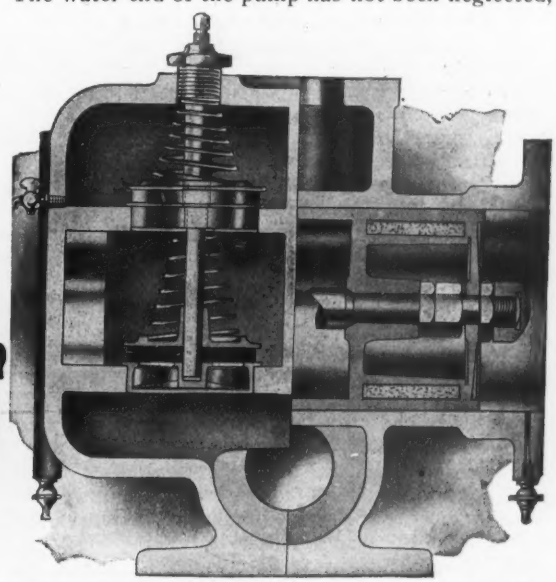


FIG. 3. WATER CHEST SHOWING VALVES AND PISTON

and the principle feature of the design, as shown in Fig. 3, lies in the ready accessibility for instant inspection of the valves. This is accomplished by removing the flat side plates and without interfering in any way with the pipe connections or air chamber.

The valves number 4 or more, according to the size of the pumps, 2 valves being operated on 1 steam, arranged 1 above the other, so that by unscrewing the plug on top of the valve chest and drawing out the stem, both are released. The valves are made with extended guides, which assures even wearing and square seating, and affords perfect alignment.

These boiler feed pumps are the product of the DuBois Iron Works, of DuBois, Pa., and their distinctive features will be thoroughly appreciated by all engineers.

MANUFACTURER AND DEALER*

How Far Should the Maker Limit and Control the Distributor?

By D. K. Swartwout

FROM time immemorial, organization has been recognized as the most effective means for the accomplishment of things and when conducted under wise leadership, along legitimate lines, for the good of all its members and for the welfare of the community it aims to serve, is to be commended and encouraged.

From the beginning it has been considered unsafe for man either to live or work alone. When the Creator placed Man upon the Earth, he recognized his shortcomings and created for him a companion—Woman. This was the first organization and, although she has kept him in hot water most of the time since, nevertheless few of us would willingly part with her.

In order to determine "Why every prominent manufacturer of supplies and machinery should be enrolled in our membership" it will be necessary to come to some understanding concerning the aims and objects of this association; what it was created for; whether it is gaining ground along these lines and whether its members individually or as an organization are making the most of their opportunities.

The legitimate scope of this organization, as I see it, is to create and to maintain the most cordial relations between the manufacturers and dealers, through whom members of this association elect to market their wares; to formulate and put into operation better methods of distribution and to encourage the making of better goods, to the end that higher ideals to the mutual interests of both manufacturers and dealers shall prevail. But a few of the principal points can be touched upon within the limits of time allotted to me.

If we elect to market our products through the dealer, we should recognize that he is conducting a legitimate enterprise and honestly and loyally support him. On the other hand, if the dealer wishes to be recognized as the logical and exclusive agent of the manufacturer, he should be an agent in the fullest meaning of the term, and furnish to the manufacturer active, intelligent and loyal representation.

If we recognize the dealers as our authorized agents we have the undoubted right to formulate certain fixed policies for the conduct of our business through them, that the dealers should respect. Among these policies is the right to determine the conditions under which our goods shall be sold; the terms of payment when purchased by the dealer; the fixing of a fair resale price; and the right to compel its maintenance. These are our fundamental rights and must be jealously guarded and not surrendered; otherwise the tail must necessarily wag the dog.

There are other equally essential things that make for successful representation which are, possibly, not within the province of the manufacturer to dictate to the dealer, but on which, because of his broader experience, he can and should be permitted to offer effective aid to the dealer.

Many of the manufacturers of this association have carried on a successful business for 2 or more generations and have acquired valuable experience, in the marketing of their products. On the other hand, but a small percentage of the dealers have been in business for any extended period and we should not expect them to possess the business sagacity that only follows a long experience in specializing.

Dealers are springing up all over the country and it should be the duty of all manufacturers to use their influence to guide them along safe and sane lines that they do not become disturbing elements in the business.

I am clearly of the opinion that, if the methods of any dealers are crude and unwise, the fault lies entirely with the manufacturer because it is his right, if he chooses to exercise it, to compel the dealer to adopt methods to his liking or to market his goods direct. We, as manufacturers, are responsible for our agents, and if we make the dealer an agent and neglect to retain that control over him that belongs to us, the dealer is not to blame. If the dealer gives you notice that he intends to take 2 per cent for cash in 10 or 40 days, when your terms are net, return his check and refuse to fill any more orders. If he does not maintain prices, ask him to reform before you let your salesman call again. Exercise your right to direct the distribution of your goods. As a matter of fact the dealers are actually handicapped and crippled, because we, as individuals and as an organization, neglect to assume this responsibility.

The greatest weakness of the dealer is the lack of intelligent salesmanship, and his prevailing policy will not create salesmen. He makes the mistake of illustrating and trying to sell too many things. In going through a dealer's catalog a short time ago I found illustrated: 3 makes of chain hoists, 4 makes of exhaust heads, 3 makes of steam separators, 3 makes of engines, 2 makes of boilers, 3 makes of radiators, 2 makes of pulleys, 2 makes of chains, 9 makes of steam traps, 4 makes of damper regulators, etc.

These items represented a variety of designs, differing in price and necessarily in grade.

Now you can't serve God and the Devil. You can't serve 2 masters. It is impossible to court 2 girls at the same time without getting in a row with both, and, likewise, a dealer who attempts to sell 2 or more lines, for the same service, whether they differ in quality or not, can be loyal to none.

The plan under which the dealer is now working cannot possibly produce salesmen. To create a salesman, he must sell a good thing at a good price. You cannot build a salesman by selling cheap things. There are too many supply salesmen working for from $50 to $80 a month, trying to keep a family, present a respectable appearance and pay 40 cents a pound for butter and 35 cents a dozen for eggs. Now, I grant that a salesman must pass through a period of probation; that he must pay for experience, and creep before he walks. But a salesman under intelligent leadership who cannot earn $100 or more a month after a year's service should be displaced by one who can.

We should choose wisely the men who are to rep-

*From an address delivered at the joint meeting of the American Supply and Machinery Manufacturers' Association with the National Supply and Machinery Dealers' Association.

resent us, train them carefully, and treat them liberally. Only 1 dealer of whom I have any knowledge makes a systematic effort to train salesmen, and he has in 12 yr. grown from a modest beginning to be one of the largest dealers in a large city of large dealers.

Few employers of salesmen teach the moral side of salesmanship, and urge the importance of clean men, clean clothes, clean hands and smooth shave, well polished shoes, etc., and all of these things have a potent influence on sales.

And then, Mr. Business Man, when this dealer has created this A No. 1 salesman, do you recognize him in the proper manner? Too many business men seem to feel that any kind of a man is good enough to meet and negotiate with a salesman. They frequently hire a mere clerk for $15 a week as a "buffer" to see and to talk to a $3,000-a-year salesman. This "buffer" is often inexperienced, sometimes unacquainted with the goods to be bought and has not even been taught the rudiments of honest buying.

If there is 1 place in an office where a courteous, level headed, considerate business man is needed, it is in the buying end. Every caller upon a buyer has some influence, and a courteous, diplomatic, fair buyer can use that influence for the advancement of the prestige of his company. I know a large corporation that has a buyer who cannot differentiate between self-esteem and egotism, who will only see advertising men by appointment; when they do not have an appointment, he insists on talking to them, very briefly, by 'phone from an upper office, while the advertising man holds the other end of the line in the lower office, in the presence of a number of employes. Such lack of wisdom is amazing.

Why, if necessary, I would get up in the middle of the night and walk 4 blocks in the snow in my pajamas to talk with an advertising man. Probably no class of business requires such a high order of talent as that of an advertising solicitor, and advertising men with scarcely an exception are among the brightest, keenest and most courteous business men that we meet. To be sure, they romance a little, and paint a picture of the head of the family, after a hard day's work burning the midnight oil to pluck the gems of wisdom from their respective journals, but their optimism is good for the blues. The wrong kind of a man to meet the men who call at the business office can vitiate a good percentage of publicity that is put out in the advertising end of the business.

THE BLISS STEAM TURBINE

The adapatability of the steam turbine for various purposes is too well known to need any discussion.

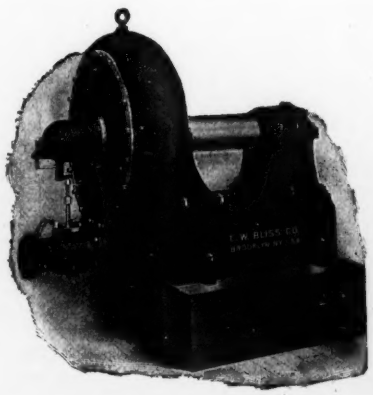


FIG. 1. THE BLISS STEAM TURBINE

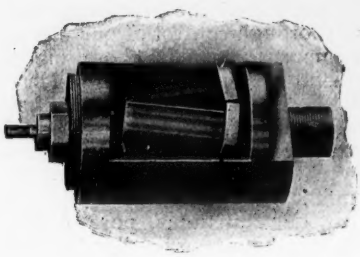


FIG. 3. GOVERNOR USED ON THE BLISS TURBINE

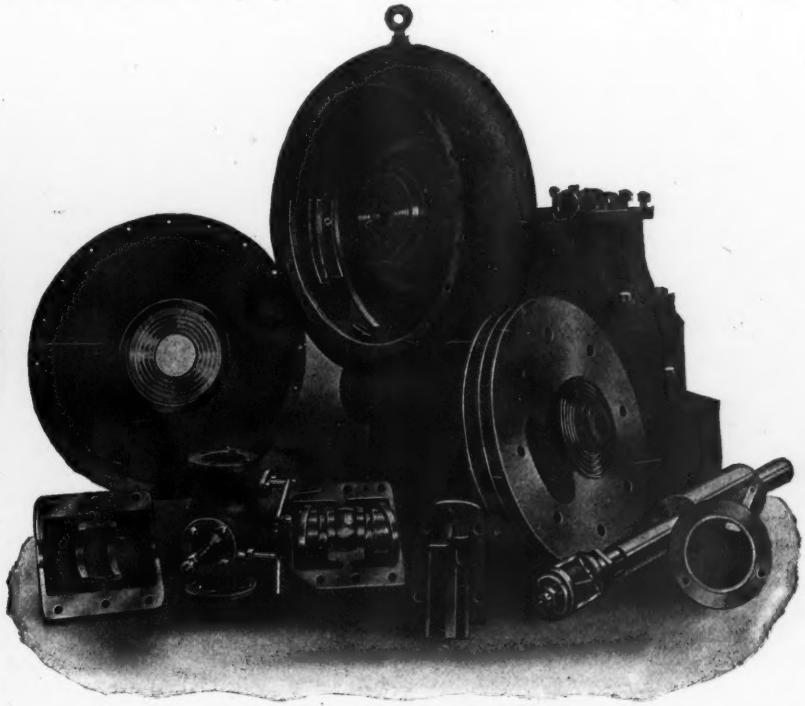


FIG. 2. PARTS OF THE BLISS TURBINE. READING LEFT TO RIGHT: UPPER ROW, CASING COVER, CASING AND PEDESTAL, ROTOR WHEEL; LOWER ROW, MAIN BEARING CAP, CONTROL VALVE, BEARING AND CAP, NOZZLE, GOVERNOR AND SHAFT, GOVERNOR CASING

Its advantages have also been stated over and over again, but the development of the use of the steam turbine in the smaller sizes is a thing that has not received so much attention, as that of the larger sizes. In the Bliss turbine, a single solid wheel runs in a cast-iron casing, with a clearance of 1/16 in. around the circumference, so that only the metal in the shaft and bearings come in contact. There is, therefore, a minimum possibility of breakage, and the clearance is sufficient so that water will do no harm when passing through the turbine.

In the casing, the steam chest is carried concentrically around the outside and delivers steam radially inward to each of the nozzles. This keeps an even temperature all around the circumference.

The turbine wheel is made of a solid piece of open-hearth steel, having the buckets milled into the out-

side circumference, thus getting a substantial construction. The blades, which separate the buckets from each other are made of a special anti-corrosive metal, and as is indicated in Fig. 2, the circumference of the wheel is smooth, so that no harm can come to the buckets even should the outside of the wheel touch the casing.

The turbine is of the impulse type, steam expanding completely in the nozzles, so that there is no difference in pressure between the buckets on the wheel and the reversing chambers consequently there is no loss from leakage. The reversing chamber is com-

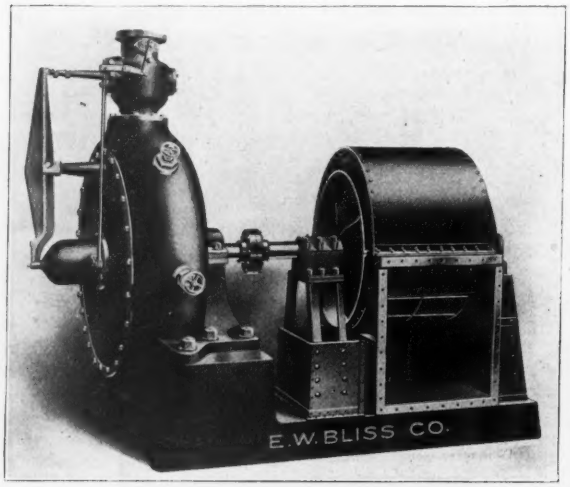


FIG. 4. TURBINE DIRECT CONNECTED TO FAN

mon for all reversals, so that steam runs on a film of steam instead of on metal, thus reducing frictional losses. Steam passes through the buckets, then through the reversing chamber, then through the buckets again. This cycle is repeated again and again until all the energy in the steam is removed, the number

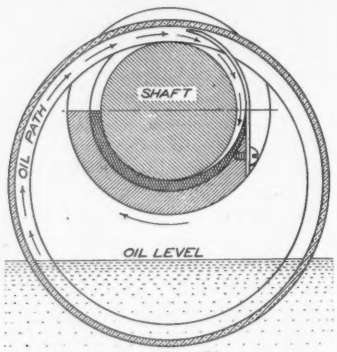


FIG. 5. LUBRICATOR FOR SHAFT BEARING

of times that it will pass depending upon the steam pressure, and the speed of the buckets.

In the smaller machines, only 2 bearings are used, the wheel is over hung, the center of gravity on the rotating part, however, is inside the edge of the bearing, which is of the spherical type and amply proportioned. Bearings are oiled by ring system of lubrication, the rings being made channel shaped and having a scoop at the top of the bearing which must take the oil out of the ring and carries it to the bearings necessary.

The governor consists of 2 revolving weights, supported upon hardened steel knife edges, and controlling a balanced governor valve through knife edge connection. An emergency governor is also provided to operate from a separate valve and is set at a predetermined speed, so that no running away is possible. As indicated on the inside of the casing in the hub of the wheel in Fig. 2, the packing around the shaft is steel labyrinth, in which there is no contact between the stationary and rotating rings. This form of packing prevents frictional losses and does away with any troubles from the use of a stuffing box or carbon packing around a high-speed shaft. The Bliss turbine is the product of the E. W. Bliss Co. of Brooklyn, N. Y.

GRAPHITE AND LUBRICATION

Carefully prepared statistics show the mined production of crystalline graphite in the United States in 1908 was 3,433,033 lb., valued at $149,763, while the same authority states that the output of electric furnace graphite in 1908 was 7,385,511 lb., valued at $502,667. These figures are most interesting in that they define how man, aided by science, has developed a process that gives to the world more graphite every year than is mined in the United States. The graphite made by man is an electric furnace product, and unctuous, pure graphite, in the various forms in which it is available, has become such a popular and efficient lubricant that it is instructive and interesting to read of the progress the world has made as portrayed by Orrin E. Dunlap, secretary of the International Acheson Graphite Co., Niagara Falls, N. Y.

"All Acheson graphite is made in the electric furnace. All other graphite is mined. In our method we control every ounce of raw material that enters our furnaces, and we control the furnaces during the entire time period of their operation. We make many grades of graphite and esteem each as the best of its class, because, through the thorough control of our material and the process, we impart to graphite those qualities essential to its successful use in the field to which the various grades are applied. Surrounded by these most unusual creative conditions, it is easy to understand that we should be expected to make graphite superior to that developed by nature in the hit-and-miss, accidental process she unknowingly applied.

"With respect to our unctuous, pure Acheson graphite, Webster defines 'unctuousness' as 'the state or quality of being unctuous, or of resembling oil; fatness; oiliness.' From the above definitions, it is evident that the condition of being smooth, polished or glassy, does not necessarily constitute unctuousness. A film of oil or fat is unctuous owing to its ability to move under pressure amongst its own particles. This property is one of the most important characteristics of a lubricating body, and only so far as the body is capable of this interior movement of its own particles is it a true lubricant.

"Unctuous Acheson graphite, being largely composed of pseudomorphs of decomposed carbides, is unquestionably capable of a movement within its own molecules, and is, to that extent, a true lubricant.

"When we consider the problem of lubrication, we should always bear in mind the fact that the surfaces of the metals composing even the highest finished bearings, when examined with a magnifying glass, are found to be quite irregular, presenting microscopic cavities and projections. If the graphite be in crystalline or compressed flake form, it is conceivable that these flakes may become impaled on the microscopic points. If impaled, is it not evident that the metal

points must have penetrated or pierced the flake? In fancy we liken these flakes of graphite to a small boy impaled on a picket fence, his legs trying to reach the ground on one side, his hands trying to do similar service of rescue on the other side throughout the period of his sufferings, and without relief.

"On the other hand, let us note that if the graphite used be unctuous, pure and soft, it will with great ease adjust itself to the microscopic irregularities of the surface, filling up the hollows and burying the points, thereby producing a mirror-like surface of great density, quite capable of withstanding continued wear and affording the highest form of lubrication. The filling up of the hollows and the burying of the points is the climax to be sought in graphite lubrication, and beyond question the longer unctuous, pure graphite is used the better will be the results.

"Brightness or blackness in graphite is no indication of quality or relative purity. Brightness in a graphite is evidence of ability to reflect light, and to do this requires a particle of some measurable size, and of a compact, homogeneous nature. Hard, tough, graphite is far less valuable as a lubricant than unctuous, pure, soft graphite that possesses great spreading, covering and polishing power.

"The black, unctuous character of graphite makes it possible to adulterate any form of this material in such a manner as to be impossible of detection by the eye, except where the adulteration is very great. But proper laboratory tests of a very simple character will readily detect this fraudulent practice, and the trade is perhaps best protected by dealing with a firm of recognized standing, which is prepared to and will at all times guarantee the purity of its product. We may add that unctuous, pure Acheson graphite is always sold under a guarantee that it has a purity content of at least 99 per cent, and we esteem it as the purest and best graphite in the world.

"It was only recently that Prof. Charles F. Mabery of the Case School of Applied Science, who is one of the highest expert authorities in the United States on oils and their qualities of lubrication wrote us as follows:

" 'The importance of the general use of graphite in lubrication in the world-wide saving of power cannot be estimated, also its possible prolongation of the natural supply of petroleum, while from what I have seen of your processes, deflocculated graphite can be manufactured as long as carbon in any form is obtainable, leading me to consider graphite the future lubricant of the world.'

"Prof. Mabery refers to deflocculated graphite. This may be a product wholly unknown to many readers. We may explain by saying that both natural and electric furnace graphite are reduced to powder form in pulverizers or similar apparatus, while deflocculated graphite is unctuous, pure, Acheson graphite reduced to practically a molecular condition, the finest state of subdivision, by a process invented by our Dr. Acheson. This deflocculated graphite is rendered so fine that it remains suspended in oil or water and may be passed through the finest filter paper made. It is this remarkably fine graphite which is destined to revolutionize the art of lubrication, and must be accepted as the very latest aid science has brought to mankind to assist in that part of the world's work dependent upon lubrication."

JUST THINK OUT your work,—then work out your think.

CATALOG NOTES

THORDARSON'S ELECTRICAL SPECIAL TIES are described in a neat catalog just received. These include induction coils and transformers for automobile and domestic use, and high potential transformers and induction coils for testing and experimental work.

THE STEAM APPLIANCE CO of Milwaukee, Wis., in a new catalog No. 16, entitled Steam Specialties, describes separators for steam and oil, in vertical, angle and horizontal types, with and without separating chambers. An ammonia separator or oil trap is also a feature of the catalog as well as the Keagar Corliss valve steam trap, and the Peter's pressure regulator. The booklet is an attractive one, and worth sending for.

THE GOULDS MFG. CO. of Seneca Falls, N. Y., is pushing, through folders, the sale of its Pyramid double-acting piston pump, which has the shaft bearings babbitted and mounted on the frame or body of the pump and gear and pinion, both machine cut from solid metal, has a brass lined cylinder, a brass encased

piston rod, and brass valves, and seats, a piston packed with cup leather, and an arrangement which makes piston and valves easily accessible without disturbing pipe connections. Suction can be taken from either side and discharge can be turned in any of 4 directions.

FROM THE DU BOIS IRON WORKS of Du Bois, Pa., comes an interesting booklet on Steam and Power Pumps. These pumps are made for boiler feeding, special mining, general service low pressure, tank work, circulating, condensers and a lot of other special applications. They have but one valve which is shown in full in the catalog and the action very interestingly described. They are made for steam, electrical belt, or gasoline engine driving, samples of each style being fully illustrated.

The book is particularly satisfactory in listing of sizes of pumps, and power required to drive each, and is a fine book to possess, as well as having full information.

GENERAL CATALOG NO. 37 of the Chain Belt Co. of Milwaukee illustrates and describes a large line of link chains for all kinds of conveyor work, sprocket

wheels, clutches, buckets and carriers, pulleys and gearing, hangers, shafting, boxes, couplings, etc., a line of concrete mixers, and miscellaneous supplies of related character. It gives also an important table of the horsepower of detachable chain belts, the allowable working strain on each kind, and the proper diameter of sprockets to be used.

It is a substantial cloth-bound book of over 300 pages, handsomely printed, and well worthy of a place in an engineer's library.

ONE OF THE HANDIEST little pieces of advertising that we have seen is the Boiler Equipment Cards sent out by McLeod & Henry Co., of Troy, N. Y. This concern manufactures the "Steel Mixture" for boiler furnaces and for the convenience of persons ordering Steel Mixture for furnaces McLeod & Henry Co. has made up in postal card form a series of private mailing cards addressed to the company and having on the message side sketches of the different kinds of boiler furnaces and a table for the dimensions needed in ordering. It is a novel idea and one which will unquestionably give results to the originators.

TWO INTERESTING BULLETINS have recently been issued by the Allis-Chalmers Co. No. 1615 describes the big hydraulic plant at Sioux Falls, S. D., showing the arrangement of machinery and describing in detail the results obtained on test of the apparatus. 1617 describes similarly the plant of the Concord Electric Co., at Sewall's Falls, and shows some novel constructions in the turbine machinery there installed.

CATALOG NO. 3 of the Terry Steam Turbine Co., Hartford, Conn., shows in a very interesting and clear manner the construction of the Terry turbine and the detail of the different parts. It is a fine piece of printing with numerous cuts which show just what one wants to know about the machine. Curves showing the performance of a 90-hp. turbine and tables of tests on a 50-hp., a 25 and a 12 are shown, and a list of dimensions of the machine given. It's a bulletin which those wishing to know about turbines ought to have.

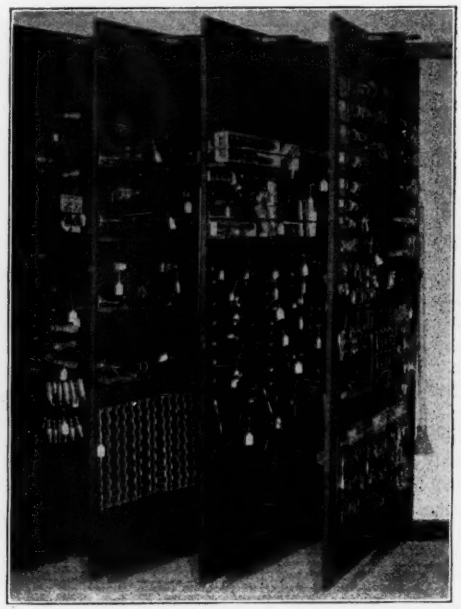
ALBERT SCHADE CO., of Philadelphia, is having a new 200-page catalog prepared by The Russell-de Wolfe Co., of Chicago. This catalog is going to be one of a totally different class on steam and water specialties and engineers' supplies, and the company state that they are trying to make it so interesting and up to date that it will be "our best salesman." The catalog will be a list of the best steam specialties and supplies that the company has been able to find, including those made by the Ashton Valve Co., G. M. Davis Regulator Co., Direct Separator Co., Mayville Specialty Mfg. Co., Pittsburg Gage & Supply Co., Richardson Automatic Lubricators and the product of other first-class concerns. The catalog will be worth while getting.

GREEN FUEL ECONOMIZER CO. has published a booklet entitled How to Save Coal, which is devoted to the use and advantages of the Green fuel economizer.

WHILE MUCH HAS ALREADY been published on the subject of tungsten incandescent lamps, the General Electric Co., in Bulletin No. 4,646, presents interesting data relative to the quality of light produced, simplicity of construction of the lamp, its adaptability to both alternating and direct current circuits, and various other data relative to its life and economy. The bulletin contains also descriptions and illustrations of high efficiency holophane reflectors for use in connection with the tungsten lamps.

THE STEPHENSON GIRL calendar for August is another reproduction of a painting by Manning. This summer girl is quite as charming as her predecessors, with which the Stephenson Mfg. Co., Albany, N. Y., has favored its friends for some months past.

JAMES M'CREA & CO. are so well known for presenting pleasing steam specialties that a special catalog is to be expected from them, and the one just issued is not a disappointment. It illustrates and describes fully the company's line of specialties, including Climax Steel Joint Clamps, Emergency Pipe Clamps, Model Flange Clamps, Century Gasket Cut-



A UNIQUE DISPLAY OF ENGINEERS' TOOLS EMPLOYED BY A NEBRASKA FIRM

ters, Skinner Valve Reseating Tools, Perfect Valve Discs, the H. H. Steam Trap and the Butman Flue Cleaner Rod.

Besides telling about the fine line of specialties, it is a fine book in appearance and can be had for the asking from James McCrea & Co., Chicago, Ill.

SECTION 23 of the catalog of the Schaeffer & Budenberg Co. describes its tachometers for stationary and portable use which are made both in indicating and recording forms.

C. H. WHEELER MFG. CO., of Philadelphia, has prepared a most interesting catalog on the pumps of its manufacture, called Bulletin No. 10. It is full of interesting information and description and shows the steam, motor and belt-driven pumps of single and triple forms for centrifugal use, for vacuum, for boiler feeding, for general tank and supply purposes and automatic pump and receivers for water supply.

FROM THE WHEELER CONDENSER & ENGINEERING CO., of Carteret, N. J., comes Bulletin No. 105, describing castings made for the sugar industry and chemical trade and incidentally the Wheeler-Edwards Patent Air Pump, the Wheeler Rotary Dry Vacuum Pump, the Wheeler Forced Draft Water-Cooling Towers, and the Admiralty Surface Condenser.

A LIFE PRESERVER for your boiler is the appropriate title of a new booklet issued by the Binghamton

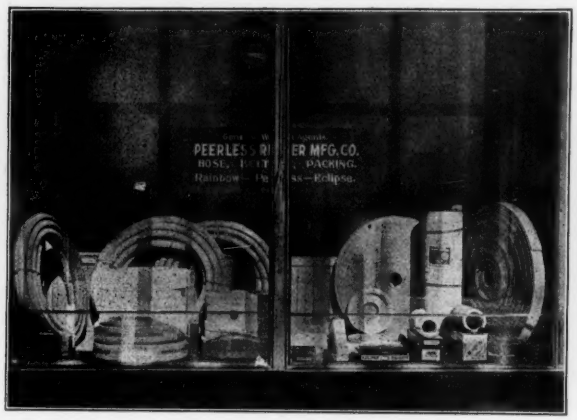
Boiler Compound Co. of Binghamton, N. Y., and showing the results in prolonging the life of a boiler, which may be obtained by the use of Pyramid Boiler Compound.

BULLETIN No. 371 of the Triumph Electric Co. of Cincinnati, Ohio, describes fully its adjustable speed motors, the speed of which is altered by field control. The special features are, wide adjustment of speed; constant speed at any given speed; constant output at any speed; heavy overload capacity; sparkless commutation at any load, and in either direction.

BRICKLINE is the name of an asbestos fire brick cement manufactured by the H. W. Johns-Manville Co. for setting up bridge walls and inner courses in boiler furnaces. It has great bonding qualities, vitrifies hard and prevents settling. It is described in a folder just sent out by the company.

TRADE NOTES

PEERLESS PACKINGS, RAINBOW PACKINGS and Eureka hose form the body of the tasteful display herewith reproduced which is to be found in the windows of Geo. B. Carpenter & Co. at Lake and South



Water Sts., Chicago. The store is western headquarters for the Peerless rubber goods and furnishes an immense amount each year to the jobbers of that section of the country. The Rocky Mountain region will be supplied hereafter from the new Denver store, but Carpenter will furnish the goods just the same.

OXOILOX BELT DRESSING, manufactured by the F. S. Walton Co., is attaining a wide sale abroad, one firm in Russia alone ordering four barrels a month. If OXoilOX "Makes Belts Pull Like Chains" as the manufacturers claim, it is not surprising that it is attracting such wide attention. It is certainly made of the right material, for there is nothing better than neatsfoot oil, its basic ingredient, for keeping belts pliable and making them hug the pulleys.

SHIPMENTS OF MURRAY CORLISS engines by the Murray Iron Works Co. of Burlington, Iowa, for the first 6 months of this year exceeded in number those for any previous corresponding period.

SOME OF THE LARGER INSTALLATIONS recently made by the Berry Engineering Co., of Chester, Pa., are of its exhaust feed-water heaters a 1,000 hp. for the Consumers' Ice Mfg. Co., at Chester, Pa., full equipment of feed-water regulators for the Philadelphia Rapid Transit Co., Philadelphia, another installation for A. Wilberts' Sons Lumber & Shingle Co., Plaquemine, La., one for the Brush Electric Light & Power Co. at Galveston, Tex., and a plant for the Montreal Water Works, Montreal, Canada.

GREENE, TWEED & CO., of New York city, are putting on the market a new antifriction metal known as the Manhattan for general use on bearings of all machinery which run at high speed or have to carry heavy pressure. It is an alloy made especially for the purpose of resisting heat and producing a smooth, frictionless surface, and when melted will flow evenly into the bearings and mold into a dense, tough structure having the right amount of hardness and rigidness to withstand strain and wear, and the greatest amount of elasticity consistent with these other requirements.

THE BALL ENGINE CO. has the contract to furnish 3 high-speed engines for the Blackstone Hotel now being erected in Chicago. These engines will be direct connected to generators made by the Western Electric Co., 1 of 300 and 2, 200 kw. capacity.

THE CHICAGO STORE of Schaeffer & Budenberg, 339 Dearborn St., of which the attractive show windows are illustrated, supplies the trade with the company's specialties over a large territory extending from Pennsylvania to the Rockies. All kinds of brass specialties

are handled, but especial attention is given to indicators, recording gages and thermometers, tachometers, speed recorders and counters, pyrometers, draft gages and calorimeters. W. H. Shenton is the energetic manager in charge, with J. Nienhuis as salesman.

THE NEW YORK CONTINENTAL JEWELL FILTRATION CO. is installing a filter of 4 basins, with a capacity of 2,500,000 gal. per day, for the Iowa City Water Co. The principal impurity to be removed is iron and the water will be used for commercial and household purposes.

THE MURPHY IRON WORKS has recently put into operation 4 of its automatic stokers, with a capacity of 400 hp. each, in the power plant of Indiana and Michigan Electric Co. at South Bend, Ind.

THE UNDERFEED STOKER CO. reports recent sales of its Jones Underfeed stokers amounting to 23,829 hp. of which 11,159 hp. represents repeat orders. A noteworthy fact is that among the list are 6 educational institutions and 5 hospitals that have chosen the Jones stoker because of its merits in competition with other makes.

THE HOPPES MANUFACTURING CO. reports the sale through its New York office of 3 of its Class R feed-water heaters aggregating 85,000 hp. Two of these machines, of 30,000 hp. maximum capacity each, were sold to the Transit Development Co., New York

city, and the other of 25,000 hp. to the Metropolitan Street Ry. Co., of the same city, and they will doubtless represent the largest installations of their kind in single units in the country.

A few of the other recent important Hoppes sales are 3 500-hp. Live Steam feed-water purifiers to the Whitaker-Glessner Co., Martins Ferry, Ohio; 1 1250-hp., Live Steam feed-water purifier and 2 2500-hp., feed-water heaters to the Gardner-Harvey Paper Co., Middletown, Ohio; 1 4000-hp. feed-water heater to the Indiana & Michigan Electric Co., South Bend, Ind.; 1 24-in. and 1 26-in. exhaust head to the Merchants' Heat & Light Co., Indianapolis, Ind.; 1 22-in. oil eliminator to the Western Ohio Railway Co., St. Marys, Ohio; 1 10-in. receiver separator to the Chattanooga Electric Co., Chattanooga, Tenn.

This list is of a few of the larger and more important orders which the company has recently received and it reports that business in the small size installations and those of medium capacity has been even more encouraging.

THE INTERBOROUGH RAPID TRANSIT CO., New York City, has adopted Keystone Grease, the high-grade petroleum-oil lubricant manufactured by the Keystone Lubricating Co., Philadelphia, for all the escalators at its "L" stations. These machines are motor driven and the larger escalators have several motors, for the different parts. As these installations are a public service proposition it is absolutely essential that they be kept running without fail, hence, their proper lubrication is all-important. This grease was adopted after careful investigation and test, because it remains in the bearing where it belongs, does not drip, or run away, and gives low friction and reliable service under all conditions. This service is particularly severe because of the sudden and variable loads on the machinery.

AT BOTH THE WISCONSIN and the Indiana local conventions of stationary engineers recently held at La Crosse and at Evansville, the large line of packings shown by the H. W. Johns-Manville Co. made their exhibit exceptionally popular. Although for many years this company has been among the largest packing manufacturers in the United States, their line of packings has been more than doubled within the past year. There is probably not a style or type of packing on the market that they do not now manufacture. At La Crosse Mr. Frank T. Guta represented the company and was also a delegate to the convention from Milwaukee. Mr. C. S. Padgett, manager of the Milwaukee Packing Department, and Mr. W. F. Taylor were also at the exhibit. The Evansville convention was in charge of Messrs. H. Lawson and O. E. Wehr, both from the Milwaukee branch.

PEERLESS RUBBER MFG. CO. announces that through Geo. B. Carpenter & Co., its agent for the western territory, a new store has been opened at Denver, at 1556 Wazee St., in the Sugar Bldg., the telephone number being Champa 769.

Full lines of the Rainbow Packing, the Peerless Stem and Valve Rod packing, Eclipse tubular gaskets, Peerless hose and rubber belting, tiling and flanges will be carried in stock, in charge of D. L. Cubberly, manager.

CANFIELD MANUFACTURING CO. is making a unique offer this month. In connection with a large sample can of Ambest Metallic Packing which is offered free in order to give engineers an opportunity to test its merit, the company is also offering a pair of socks, black or tan which are guaranteed. It is not stated definitely how many times these will be replaced if the first pair should not stand the test, but the coupon is worth filing in anyway. We understand Ambest Packing is making quite a stir among engineers at the Pacific-Yukon Exposition where the exhibit is in charge of Mr. John Canfield.

THE LAGONDA MFG. CO., of Springfield, Ohio, makers of the Weinland boiler tube cleaners, automatic cutoff valves, and other boiler room specialties, announces the opening of a new branch office in the Postal Telegraph Building, Chicago, Ill. J. P. Maloy, who takes charge of the new office, is one of the best known boiler cleaner men in the country. He is thoroughly familiar with all types of boilers and different conditions of scale and has traveled extensively throughout the United States and made several trips to the Hawaiian Islands. His familiarity with scale conditions enables him to give the best advice upon the cleaning of boilers and the selection of proper tube cleaners. "Pat" is ready to discuss boiler scale with anyone and will tell him how to meet the toughest scale proposition. In this department he will be assisted by F. H. Field, who was formerly connected with the St. Louis office of the Lagonda Manufacturing Co., and who has had several years' experience in cleaning boilers.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rate of 40 cents per line. About nine words make a line. No display type is allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED by practical engineer. Three years where now employed. Good reason for changing. Married, reliable. Address Box 114, Practical Engineer. 9-1

POSITION—Either as steam or gas engine engineer. Have first class Ohio license. Thoroughly acquainted with generators and motors and all modern power plant appliances. Best of reference as to character and ability. Address Box 111, Practical Engineer. 8-2

POSITION—Experienced gas engineer and producer operator with experience in operating rental station equipment, both A. C. and D. C. types, who is employed at present, desires change. Would prefer plant using natural gas. Address Box 109, Practical Engineer. 8-2

POSITION—By young engineer as chief engineer in small or medium size electric light or power plant, eastern Pennsylvania preferred. Now employed. but have reasons for change. Am no globe trotter. Married. For further information address Box 108, Practical Engineer. 8-2

POSITION—Position of supervising and inspecting engines with large company. Am holding such position at present, having charge of power plants, machinery, etc. Making boiler and engine tests and having general supervision of plants and machinery. Address Box 107, Practical Engineer. 8-2

POSITION—Young man, 22 years old, strictly sober, attentive and willing; machine shop experience, steam fitting, low pressure, firing, motors and light wiring, wishes position in engine room as helper or oiler, or in large manufacturing plant. Address R. Streller, 103 W. 80th street, New York city. 8-2

POSITION WANTED as engineer. Have had 16 years' experience with all kinds of boilers, pumps and generators. Economy guaranteed. Will be at liberty November 1st. Give full particulars in first letter. Location not important. Address Wm. J. Collins, Box 2751, 21st and Fairmount avenue, Philadelphia, Pa. 9-2